The Journal

OF THE

Royal United Service Institution.

VOL. IV. 1860. No. XIV.

LECTURES.

Tuesday, March 6th, 1860.

Colonel the Honourable JAMES LINDSAY, M.P. in the Chair.

HOW OUGHT VOLUNTEER RIFLE CORPS TO BE ACCOUTRED?

By Capt. J. M. CARTER, Adjutant Royal Monmouthshire Militia.

IN answering the question, How ought Volunteer Rifle Corps to be accoutred? I am afraid that some of you will think I am expecting too much from the Volunteer Force. Should this opinion be entertained by any, I feel sure a little just consideration will dissipate it.

It is to the period of actual invasion that the practical Rifle Volunteer will look, and for it he will strive to prepare. Whether it be the colour or design of his dress, or the amount and sort of drill he should practice, or the accoutrements he should procure, he will readily admit that everything should be governed by this consideration, What will render me most efficient when my services shall be required by my country?

Evidently there has been a growing tendency to require something more from Rifle Volunteer Corps than was at first contemplated. In May, 1859, we were told by a War Office document that "it should not be attempted, as regards Rifle Volunteers, to drill or organise them as soldiers expected to take their place in line, which would require time for instruction that could ill be spared; but it should be rather sought to give each individual Volunteer a thorough knowledge of the use of his weapon, and so to qualify the force to act efficiently as an auxiliary to the regular Army

and Militia, the only character to which it should aspire." Now the sort of impression that I received at the period in question amounted to about this, that Rifle Volunteers were to make themselves accomplished shots by some royal road.

But, although Rifle Volunteers were not to aspire to take their place in line with others of Her Majesty's Forces, they were nevertheless to aspire to act as Riflemen or Sharpshooters in the field, or, in other words, as I understand those expressions, as Light Infantry Troops, whose duties are the most difficult as well as the most important, and which consequently require the best-drilled soldiers to perform. In the present Field Exercise book you will find this fact very clearly stated. It says, "The duties of troops employed as Light Infantry in the field are both varied and important; to them the safeguard of the camp is usually entrusted, and by them the cantonments of the army are protected from the sudden or unexpected approach of the enemy. When the army is in motion, the Light Infantry reconnoitre the country in its front, feel for the enemy, or clear the way for the columns when advancing, and protect them from being too closely pressed upon or harassed when retreating; they conceal and cover the movements and manœuvres of the line, watch the motions of the enemy, and ascertain the nature of the ground and country in advance of the main body; upon their efficiency the General often very much depends for the necessary information to enable him to regulate and direct his columns."

Though these remarks were intended to apply to a more lengthened and a more systematic warfare than is likely to occur on the shores of Great Britain, still the necessity of well drilled soldiers would not be the less required for Light Infantry movements whenever an enemy invades our land. Besides, to repel effectively the landing of an enemy, it would seem more probable that it would be desirable to *concentrate* troops at certain points rather than *disperse* them, and to take up positions in battalion, rather than as Light Infantry.

The very independent action which the document referred to seems to recommend as the sole object of Rifle Volunteers, was soon, to use a military expression, undermined, for in the following July it was recommended in another document from the War Office that "the uniform and equipments of all the corps . . . . should be as far as possible similar . . . . within the same county, in order to enable the Government at any time to form the corps *into battalions*."

Again, in August 1859, "Mr. Secretary Herbert desires to impress upon the Officers of the Artillery and Rifle Volunteer Force the importance of qualifying themselves, as completely as they are able to do, for the adequate discharge of their military duties. In order to assist their efforts in this direction, he has made an arrangement with His Royal Highness the General Commanding in Chief, for temporarily attaching such officers as may desire instruction to Battalions of the Regular and Militia Artillery, and to regiments of the Line and Embodied Militia Infantry."

These memoranda evidently, to my mind, indicate that it is thought necessary Rifle Volunteer Corps should know something more than how to act as *independent* Riflemen or Sharpshooters, for independent they certainly would have to be if they were unable to perform all those duties

in the field which a general or other officer, under whom they would on actual service be placed, would require.

The Rifle Volunteer Corps have been raised under the provisions of 44 Geo. III. c. 54. The Yeomanry and Volunteers are therein classed together. Every one who has seen the inspection of a Yeomanry regiment must know that they are as completely equipped as any regiment of Cavalry in Her Majesty's Forces, and that they perform the chief cavalry evolutions. The number of days in the year that Yeomanry regiments are drilled is 12, the number required from the Volunteer Force is 24. Why then should Rifle Volunteers not aspire to take their position in line? The amount of instruction necessary to their doing so need not be unreasonable. Let them but make themselves masters of *the company* drill, they will then (if the officers take advantage of Mr. Sidney Herbert's offer to attach themselves for a while to Regiments of the Line, or embodied Militia Infantry), be equal to the performance of any duties in battalion, as also in brigade, because, as the Drill-book says, "The evolutions of a battalion are effected by a combination of the minor movements of squad and company drill. The rules for the positions and movements of officers, non-commissioned officers, and privates, are applicable, with very few exceptions, to all the movements of a company, when in the battalion," and "A battalion may be considered to hold in a brigade or line the relative situation of a company in a battalion."

The Act of Parliament to which I have referred evidently contemplates nothing short of what I have here taken the freedom to suggest. In the 5th section it says, "No person shall be deemed, construed, or taken to be an effective member of any corps of Yeomanry or Volunteers, or shall be returned or certified as such by any commanding officer under this Act, or be entitled to any exemption under any of the provisions thereof, who shall not have duly attended, *properly armed and accoutred*, and mounted if Cavalry, at the muster or exercise of the corps to which he belongs, if Cavalry four days, if Infantry eight days at the least, in the course of the four months next preceding each Return made under this Act; unless he shall have been absent with leave, &c."

And in the 22d section it is further enacted, "That in all cases of actual invasion, or appearance of any enemy in force on the coast of Great Britain, or of rebellion or of insurrection arising or existing within the same, or the appearance of any enemy in force on the coast, or during any invasion, all corps of Yeomanry and Volunteers shall, whenever they shall be summoned by the lieutenants . . . or upon the making of any general signals of alarm, forthwith assemble within their respective districts, *and shall be liable to march* according to the terms and conditions of their respective services."

Without quoting other parts of the Act which bear upon readiness and efficiency, it is obvious that it contemplates the utmost reasonable preparation for immediate action. Though men cannot make themselves masters of a science without much practice, it would be consequently unreasonable to expect from the Rifle Volunteers equal proficiency with the Line and embodied Militia who are always at the study; but respecting equipment, no valid reason that I can see can be given why all should not be on the like footing. In the War Office Memorandum of 13 July, 1859, I find it

stated, "Accoutrements will consist of waist-belt of black or brown leather, sliding frog for bayonet, ball-bag containing cap-pocket and *twenty*-round pouch." Subsequently a Committee of Volunteer Officers recommended a pouch to contain *thirty* rounds of ammunition and ball-bag to slide on the waist-belt to contain *ten* rounds of ammunition, in all *forty* rounds. You see the Rifle Volunteers have themselves *doubled* the number of rounds suggested in the War Office Memorandum, and I feel sure they would not have hesitated to have *trebled* it, could the same have been conveniently carried.

In bringing the subject of accoutrements specially before the Officers of Rifle Volunteer Corps and Companies I regret that, with respect to the pouch, I am somewhat late, but I could not have been sooner. During the winter, I was at Hythe for a course of musketry instruction, and at that period there was not a moment I could find to bring this subject before the establishment there, which I wished to do to get an opinion as to the merits of the accoutrements I had designed, and which it was my desire to obtain before making them public. As soon as the course was over, I delivered a lecture to the Officers and Non-Commissioned Officers of that establishment, the subject being, "How ought an Infantry Soldier to be accoutred?" and which question I answered by shewing the accoutrements which I have brought here to-day for your inspection.

The very favourable reception they met with there was the means of my interview with the Adjutant General, being to me one, I may confess, of pride, for I had the gratification of being accompanied to the Horse Guards by General Hay himself. A few days after this I went before His Royal Highness the Duke of Cambridge, and on last Thursday week before Mr. Sidney Herbert, all of whom spoke in terms of approval of the accoutrements I submitted. I expect that 100 sets will be soon ordered for trial in Line Regiments. You will see, therefore, I could not have brought the subject earlier before you.

Allow me now to make a few general remarks upon the equipment of a rifleman. I limit the word "accoutrements" to knapsack, pouch and belts, and canteen, or mess-tin as it is sometimes called, as, beyond these, I am not prepared to speak. After which I purpose to shew you the practical answer I have to give to the important question "How ought riflemen to be accoutred?"

I would beg, however, in the first place to remark, that I cannot coincide with those who hold the opinion that knapsacks and pouches may be altogether, or even partially, got rid of. Such proposals are captivating, I admit, but they are not sound. It is now eighteen years since I first directed my attention to the subject of accoutrements, and, as you may suppose, I have studied it under every aspect. I believe, however, that those who advocate the getting rid of them have become inimical to their use solely on account of their inconvenient structure and erroneous principle of suspension. Could they have seen their way to a knapsack which would not impede the free action of the soldier's arms, and in no way inconvenient except as regards weight, which more or less it is impossible to avoid, and a pouch which possessed the advantages of easy access and carriage, one would never have heard, I feel sure, of such

Utopian suggestions as I have mentioned. I shall not detain you, therefore, by going into this question.

Most of you are aware that the Infantry soldier, according to present Regulation, has two pouches, or one pouch and one pocket. The pouch, which is worn behind, is made for fifty rounds, and the pocket, worn on the right front side, for ten rounds of ammunition, with an oil-bottle. This second pouch the brigade of Guards has not adopted. Its convenience is chiefly limited to those times when the larger pouch cannot well be brought to the front. All evidently admit that the most convenient place for the carriage of ammunition is behind the person. What is wanted is easy access to it.

The objections to a front pouch may perhaps be briefly stated to be—

1st. All excrescences on the front side of a soldier interfere with the proper handling of the rifle. That closeness of action which is so desirable, especially in the ranks, is necessarily prevented.

2d. It is an additional accoutrement.

3d. It is highly objectionable to carry any weight on the stomach.

I conceive that the whole weight of the accoutrements should fall as much as possible on the shoulders, and equally. No one, I am sure, is at all likely to dispute this, The only question is, how can the weight be made to rest there? Until lately, I believe, nothing heavier than a sword has been carried round the waist, and the weight of that, I have no hesitation in saying, should be otherwise disposed of. When the sword cannot be carried in the hand, its weight should rest upon the shoulder.

From these and other considerations, I aimed to obtain a pouch which has—

1st. Its position behind, with ready access to the ammunition. Front pouch consequently not required.

2d. Security against damp air. Freedom from dust and rust, so as to avoid the necessity of cleaning the tin inside.

3d. Places for a bottle of oil, a cramp, with turnscrew, worm, and picker, and gun rags.

4th. A magazine for copper caps.

A pouch which can contain so much, and which has space for seventy-two rounds of service ammunition, you must not expect to see so small as the one now worn by the soldier; but as it is placed behind, where size is comparatively unimportant, I have thought it right not to sacrifice the advantages I have mentioned to appearance. Notwithstanding, however, viewing the soldier as he stands in the ranks, the appearance of my pouch is actually smaller than the one previously in use, for it is, I think, an inch and a half shorter horizontally.

Belts (Pouch).

The belts of the pouch are so planned that the weight now carried upon one shoulder, and diagonally across the chest, I have distributed over both shoulders. Although I have a strap which crosses the lower part of the breast, there is no strain upon it. It is merely to keep the belts in their place when the knapsack is not worn, for when the knapsack is upon the back it can be removed.

The necessity of disposing of the weight of the pouch and ammunition over both shoulders, in place of attempting to carry them round or partly round the waist and on one shoulder, must be apparent to you when I tell you that the weight of sixty rounds of service ammunition alone is 5 lbs. 8¼oz. The pouch without ammunition in it may be comfortable enough when supported round the waist; but, believe me, the weight say of 6 lbs. thus disposed could not be carried by the strongest man without great inconvenience, even for a short time, and for a continuance to many soldiers the most injurious consequences would result.

The Belts I have designed have these advantages also. A new set can be fitted to a man without any difficulty, and the pouch can be put on and taken off as easily as a waistcoast.

[The Pouch and Belts were then shown and put on.]

Knapsack.

When I first attempted to improve the mode of suspending the knapsack (in 1842) it was supported by means of two straps, which encircled the pack a few inches apart. A strap was attached to each, to pass over the shoulder and under the arms, terminating in a hook to fasten it to the lower part of the pack. To relieve the cutting pressure of the straps under the arms caused by the weight of the pack, a breast strap was employed, but which when tightened became so oppressive to the lungs that it was obliged to be discontinued. The present principle of suspension differs but little from the plan just mentioned; the chief difference consists in the straps which pass over the shoulders taking a more oblique direction by passing over the higher part of the shoulder so as to avoid as much as possible contact with the arms. I have myself tried several plans to obtain this grand desideratum, but all have failed except the one which I have lately had the honour of submitting to the authorities, and which I shall presently show to you.

I will just previously explain that I make the framework of the knapsack, which I consider under any circumstances useful for easy packing, subservient for most important uses. I do not make use of it only to give the pack a neat appearance, but to help its easy carriage.

The present knapsack, as you are aware, has its opening upon the side which presses against the back, whereby the more that is placed within the pack the greater does its convexity on that side become, so that a well filled pack cannot be adjusted to the back. The convexity of the pack and of the shoulder blades cause the pack to press unduly upon the small and weak part of the back. The placing of a forage cap or such like articles upon the lower part of the pack, to throw the upper part close into the neck, is at best but a clumsy and withal ineffectual remedy. The pack, however, since there is no weight in front to counterbalance it, cannot possibly ride without the discomfort I have mentioned unless provision is made *for its proper fit*. This I have effected in the most satisfactory manner, and it is this adjustment, in connection with what I may call a prolongation of the bottom of the pack to the front, that has enabled me to give the great advantage of freedom to the arms.

The side of the pack that presses against the back is in mine never

Fig. 1.

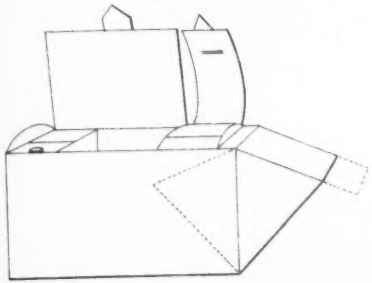


Fig. 2.

Fig. 3.

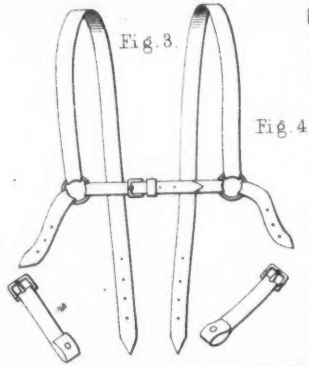


Fig. 4.

Fig. 5.

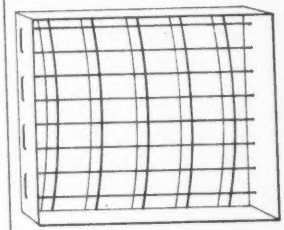


Fig. 6.

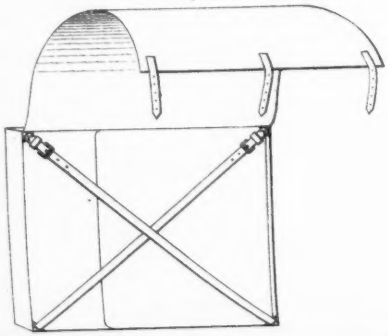


Fig. 7.

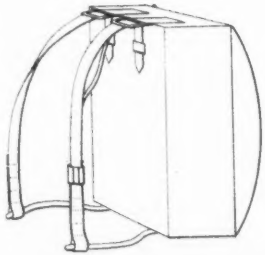


Fig. 9.

Fig. 8.

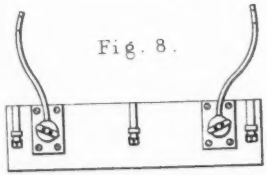
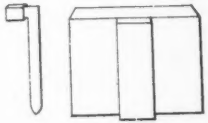


Fig. 10.



J.R.Jobbins

interfered with. Whether empty or full, it always presents the same surface. Mine is opened on the outside, and it is capable of carrying more or less than the ordinary kit according to the option of the wearer, or the requirements of the service.

The great-coat I place under cover. This is a boon that has been long wished for, but has never been satisfactorily accomplished.

The canteen I prefer is of oval shape. The cover forms a good plate. By means of a handle of cylindrical form and a couple of straps attached to it, a dozen dinners can be carried to men on guard by one man, and with greater ease than he can now carry two. This handle carries the salt.

[The knapsack, &c. were here shown.]

The accoutrements that you have now seen are those which I can confidently recommend to all riflemen. Although the pouch is capable of containing a greater number of cartridges than any which has been, I believe, ever invented, it not only is thereby, and from the easy mode of suspension, the most efficient for actual service, but it is also the most convenient for the target practice ground, when ten rounds only are used at one time.

And as Rifle Volunteer Corps will require for their convenience upon *actual service* a knapsack, it is highly desirable that they should accustom themselves to wear one. The muscles which are brought into requisition for its support will be strengthened by using, and the pack will, by occasional use, be thought less of as a burden.

The Chairman, in thanking Captain Carter for his Lecture, said that he thought the accoutrements which had been described before the meeting were well worthy of a good trial. He hoped that the authorities would order 500 sets, or at least 100, to be tried at Aldershott or elsewhere.

EXPLANATIONS OF THE PLATE.

Pouch.

Fig. 1 shews the construction of the tin of the pouch. On the left are compartments for a bottle of oil and gun rags. On the right is a magazine for copper caps. On the top of the larger lid is a place for the cramp, &c. The angular projection forms the entrance to the pouch for extracting the cartridges ; when not in use, it can be closed up ; it then assumes the position shewn by the dotted lines, the cover falls, and fig. 2 shews its appearance on all ordinary occasions. The outer covering of the pouch is leather, and brown leather is, I consider, the most suitable for volunteer corps, as it requires no cleaning.

The belts (fig. 3) carry the weight of the pouch on both shoulders *equally*. A strap crosses the lower part of the chest to keep the belts in their place. The ordinary waist-belt for carrying the bayonet passes over the pouch-belts behind only. The position of the pouch being exactly in

the centre of the back, and the whole weight divided equally on the shoulders, the equilibrium of the soldier is as perfect as it can possibly be, so that no undue muscular exertion has to be used.

By means of two straight straps (fig. 4)—the two are identical—when the knapsack is worn, the pouch can be entirely supported by passing the knapsack straps (see fig. 7) through the metal loops (fig. 4), and passing the lower ends of the straight straps through the buckles, as seen in fig. 2. On a march, therefore, and indeed, on any occasion when the knapsack and pouch are not to be separated, no other belts or straps need be in front of the body, except the knapsack straps and waistbelt. By the use of these two straps moreover the carriage of *the knapsack* is actually improved. These straps also *can* carry the knapsack in the manner that knapsacks are ordinarily carried by attaching the circular metal loop (fig. 4) on to the screw at the bottom of the knapsack (fig. 9).

Knapsack.

Fig. 5 represents the frame of the knapsack, and which I consider indispensable for proper carriage and easy packing. Without a frame, a kit, when compressed, inclines to a rounded form, which is fatal to proper carriage, hence the necessity of a frame which is concave on the side that comes in contact with the back with the view of its fitting it. It becomes then a part as it were of the person, and the weight of the pack is brought as near to the centre of gravity of the wearer as it is possible to bring it. With sides moderately deep, the kit can with two straps (see fig. 6) be tightly compressed into the smallest possible space. The two iron bars on the lower side of the frame (see figs. 8 and 9) enable me to give entire freedom to the arms. While the additional weight is trifling, the advantages are very considerable, indeed it may be safely affirmed, that the pack, as shewn in fig. 7, leaves nothing to be desired; and it can now be said, that the wearing of a pack is not only not a hindrance to one's shooting well, but is actually an assistance.

On the strap which passes over the left shoulder is a metal holder for carrying the rifle at "the slope," a hook being attached to the trigger guard (see figs. 7 and 10, which are nearly full size). The hands, as well as the arms are consequently free when so desired.

Friday, March 9th, 1860.

Captain E. G. FISHBOURNE, R.N. C.B., in the Chair.

ON MILITARY PONTOONS, WITH SUGGESTIONS FOR THEIR IMPROVEMENT.

By Captain Francis Fowke, Royal Engineers.

In reading this paper, it is not my intention to enter into any lengthened history, or to give any detailed explanation, of the principles or practice of military bridge-making or pontooning; but rather to discuss shortly and in a practical manner the merits and demerits of the system as now practised in the British service; and, as it is but unfruitful labour to stop at merely pointing out defects, I propose to introduce to you in as few words as possible a pontoon which I conceive is capable of remedying many, if not all, of the defects of the existing system.

For the benefit of non-military hearers I may be perhaps allowed to explain that, in military science, a pontoon, as understood in the British service, is a kind of boat, constructed for the particular purpose of making such temporary bridges as may be necessary for military operations in the field, in which structures it takes the place of the masonry or wooden piers of an ordinary bridge.

In building a pontoon bridge, the piers or pontoons are placed side by side in the direction of the stream; and the arches of a stone bridge are represented by beams, (or, as they are technically termed, baulks,) which are laid from one of these pontoons to the next, and covered with transverse planking (termed chesses) to form the roadway.

The construction of the pontoon bridge, as far as regards its superstructure, or bridging from pier to pier, being in principle almost the same in every instance, need not be much enlarged upon. The pontoon itself has however undergone many changes, and it is more particularly of this part of the bridge that I purpose to speak to-day; and in the first place as to the requirements to be fulfilled in the construction of the pontoon, which is to serve as the foundation for the bridge.

The principal requirements of a pontoon may be thus enumerated.

1*st. Buoyancy.*—As it is to be employed to support the passage of heavy bodies of artillery, cavalry, infantry, stores, &c., it must have sufficient buoyancy to carry the heaviest weights that are to be passed over.

2*nd. Stability.*—It must also have sufficient stability to diminish as much as possible the undulating and oscillating motions that are always communicated, in a greater or less degree, to all bridges on floating supports, by the passage over them of moving loads, whether of carriages, horses, or men.

3*rd. Portability.*—As the pontoon has to be transported along with the other stores of the army, it is necessary that it should be as light as possible, and, as the land transport is often likely to be over rough country, and as, with us at least, it is happily always necessary that the pontoons should be taken to the scene of operations on board ship, it is desirable that their bulk, and especially their length, should be reduced to within the smallest possible limits.

Thus, buoyancy, stability, and portability, may be called the primary qualifications, which it is necessary that all pontoons should possess; but, besides these, there are many other objects to be arrived at in devising a perfect pontoon, such as the quality of riding easily at anchor, being easily and quickly repaired in the field, easily bailed out, or that leaks can be easily stopped when in bridge; that the roadway should be carried at a considerable height from the water; that the pontoon should be of sufficiently durable materials to stand the hard work and ill-usage that it is sure to have, both in the water and on transport; that it should be sufficiently sea-worthy not to be swamped by the swell caused by the swift current of a river, or in bad weather; and that it should be sufficiently manageable to be easily taken to or withdrawn from its place in the bridge.

Before examining the service-pattern pontoon of our army by these tests, it will be useful to see what has been done up to the present time by other nations, in the attempt to secure for their respective armies the best possible equipment in this most important particular; and it is all the more important that we should take advantage of their experience on this point as, from the fact of their peculiar geographical positions, the continental nations are more practical pontooners, and have conducted larger operations in this respect than, with a very few and brilliant exceptions, have ever been executed by the British army.

From a consideration of the different patterns of foreign pontoons, (see Plate I.) it will be seen that there are certain properties which are common to them all.

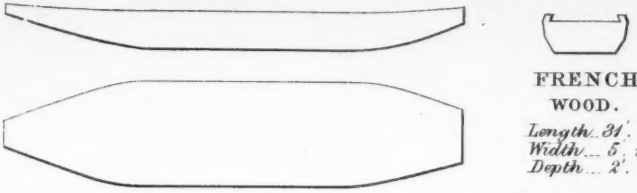
First, they are all open boats, every part of their inside being easily accessible at all times, and capable of being used as stowage room when on transport.

They all approach nearly to a common type of form, that is, they are flat-bottomed, with ends in general alike, and formed more or less like those of a Thames barge.

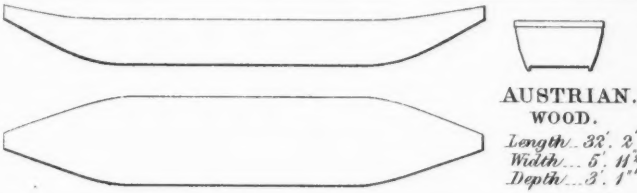
They are all of great breadth in proportion to their depth, the proportion being in most cases that the breadth is double the depth.

They are formed of four different materials, viz: wood, copper, tin, and lastly waterproofed canvas, but the same general form and dimensions have been preserved throughout, and the testimony of those who have had an opportunity of judging is, that they are much steadier and more stable than ours, but that these essential qualities have not been attained without a great sacrifice of weight, size, and consequent portability.

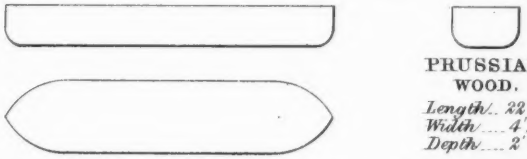
FOREIGN PONTOONS



FRENCH.
WOOD.
Length 31'. 11"
Width 5'. 10"
Depth 2'. 7"

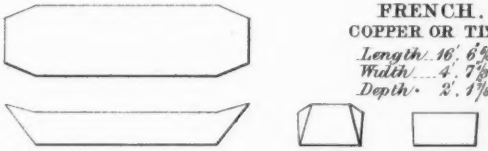


AUSTRIAN.
WOOD.
Length 32'. 2"
Width 5'. 11⅞
Depth 3'. 1"

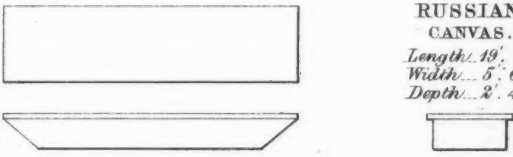


PRUSSIAN.
WOOD.
Length 22'. 4"
Width 4'. 8"
Depth 2' 6"

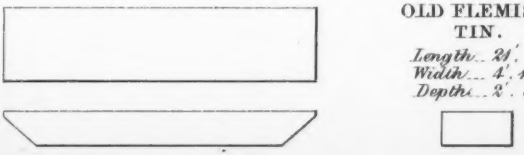
PRUSSIAN. TIN.
Length 19'. 3⅞
Width 4'. 0¾
Depth 1'. 10½



FRENCH.
COPPER OR TIN.
Length 16'. 6⅝
Width 4'. 7⅞
Depth 2'. 1⅞.



RUSSIAN.
CANVAS.
Length 19'. 7⅝
Width 5'. 0⅝
Depth 2'. 4⅜



OLD FLEMISH.
TIN.
Length 21'. 0"
Width 4'. 10"
Depth 2'. 3½

J.R.Johbins

Having seen what is the practice of continental armies with regard to the construction, form, and dimensions of pontoons, the next point that we come to, is the pontoon at present in use in the British service, of which we have a model and diagram before us; and here we are at once struck by the fact that a very wide departure has been made from the principles which have received the sanction of all foreign powers.

The British service pontoon may be briefly described as a cylinder 2′ 8″ diameter and 22 feet long, terminated at each extremity by a hemispherical end, thus making the total length of the pontoon 24′ 8″. It is constructed entirely of tin, the internal framework consisting of a number of wheel-shaped frames, which are placed at intervals, and are connected by a central tube of the same material. By every second frame being covered with a disc of tin, the pontoon is divided into watertight compartments. The pontoon is furnished with an iron ring at either extremity, for the convenience of towing, mooring, &c., and a number of sunk handles are inserted along the sides, which, besides being of use in carrying, serve as eyebolts for attaching the superstructure to the pontoon, as also for securing it upon its carriage when being transported.

When the pontoon is to be formed into a bridge, an apparatus termed a saddle is firmly lashed to these handles, and the baulks are attached to the latter, by pins passing through them, and through the wooden cleats or chocks with which the saddles are furnished on their upper surface.

The advantages that are claimed for the tin cylinders over the open boats in use on the continent, are

1*st.* That they are lighter and consequently easier of transport.

2*nd.* That, being close vessels, they are not liable to be swamped or sunk by a swell washing over them.

3*rd.* That, being all sides alike, they can at any time be turned round, so as to bring a leak above water.

4*th.* That, as the area enclosed within a circle is greater in proportion to its enclosing line or periphery than in the case of any other figure, therefore the cylinder will give the greatest buoyancy with the least weight, of any enclosed vessel.

5*th.* That the cylinder being divided into compartments diminishes the risk of accident from leakage in the event of injury by shot or other wounds.

6*th.* That with the same sectional area the cylinder will raise the roadway of the bridge to a greater height above the water than is done by the flat boat.

7*th.* That its form admits of its being rolled into the water, instead of requiring to be lifted in or launched like a boat.

The lightness of the cylindrical pontoon as compared with the flat boat of continental nations, although striking at the first glance, yet when we come to compare the two more minutely does not appear to be so great, as for instance let us take the Prussian boat, the newest pattern of which weighs 9 cwt.; the weight of the cylindrical pontoon is rather over 5 cwt., so we may take the weights as being in the ratio of 9 to 5, the ultimate buoyancy of the Prussian pontoon is about 12,000, and that of the cylinder about 7,000, so that their buoyancy are as 12 to 7; now with this ratio of buoyancy, the proportion should stand thus: 12 : 7 : : 9 : $5\frac{1}{4}$; but, as it

really stands 12 : 7 : : 9 : 5, it follows that the cylinder has the advantage in lightness of 5 over $5\frac{1}{4}$ or with equal buoyancies it would be lighter by only $\frac{1}{20}$th than the boat.

In actual portability, the Prussian seems to have the advantage from two causes: first, it is two feet shorter, which in itself is of immense advantage in land transport; and, secondly, the boat being open, the interior space, which is entirely thrown away in the cylinder, is available, and is actually used for the stowage of the superstructure and various stores which it is indispensable should be carried as part of a bridge equipment; so that, with equal powers of flotation, the cylinder is actually more bulky for transport than the Prussian boat pontoon.

These calculations are however all made upon the basis of the total displacement of the two pontoons, that is supposing them to be both completely immersed; but, as from the Prussian pontoon being an open boat it would be impossible to immerse it to anything approaching to this depth, it follows that it is really the fact of the cylinder being a close vessel, that gives it its great advantage over the continental open boat.

And this brings us to the second advantage claimed for the cylindrical over the boat pontoon, viz : "That, being close vessels, they are not liable to be swamped or sunk by a swell washing over them." This is undoubtedly a strong argument for the employment of closed vessels as pontoons, but, like many other advantages, it is only purchased at the price of many drawbacks, and those of a character that cannot be lightly overlooked; one of which, viz.: the loss of stowage on transport, has been already dealt with; but a much graver one exists in the circumstance that it is impossible to examine or inspect the state of the inside framing of the vessel, and *a fortiori* to execute any repairs to this skeleton as it were of the whole structure, without pulling the cylinder all to pieces; and the consequence is, that the most trifling defect, which at the commencement might have been remedied in a few minutes, remains undiscovered, until, by the work of decay going on unobserved and uninterrupted, the pontoon finally becomes unserviceable; and, worse than this, its state is not likely to be found out until it is in actual use, when its failure will probably result in accident more or less serious, and may ultimately be the cause of frustrating an important movement.

A third defect of close vessels is, that in the case of a leak occurring it can only be kept under by pumping, and the flotation of the pontoon is thus dependent on a small and delicate instrument, which on actual service is so liable to be either lost or to get choked or out of order, whereas an open boat can be immediately and quickly bailed out with any vessel that may happen to be at hand.

The third advantage claimed is, "That, being all sides alike, they can at any time be turned round so as bring a leak above water."

This is undoubtedly an advantage, but it also has its corresponding defect, viz.: that the pontoon being of such a form that it does not matter which side is uppermost is by this fact so balanced as it were on its axis that the application of the slightest weight causes it to roll over, and thus the pontoons are rendered totally useless for employment singly, and so helpless, that in case of requiring to use one as a boat it must be coupled with its fellow before any one could get upon it, and no pontoon can be

singly taken into its place or withdrawn from its place in a bridge, but must be formed into a raft with another pontoon before the slightest movement can be effected.

Another disadvantage is, that the deck of the vessel, which has merely to throw off an occasional wash, must be of the same strength and weight as the bottom and sides, by which the whole weight are sustained.

The waste of material caused by this form may be perhaps best understood by referring to the diagram, where it will be seen that the same quantity of covering material, if employed in a flat boat, would give a very much greater amount of buoyancy, and the want of deck might be supplied by a very much lighter material.

The next claimed advantage is, "That the cylinder being divided into compartments diminishes the risk of accident from leakage in the event of injury by shot or other wounds."

This is perhaps the most important of all the advantages claimed, but is not at all necessarily confined to the cylindrical pontoon, as it may be applied to almost any form of boat.

It is also claimed as a merit, "That with the same sectional area the cylinder will raise the roadway of the bridge to greater height above the water than is done by the flat boat."

This is true, until the cylinder is immersed up to the axis, beyond which point the immersion becomes so rapid, that any advantage on this point is more than neutralized.

Lastly, a claim is put in, "That its form admits of its being rolled into the water instead of requiring to be lifted in or launched like a boat."

Any supposed advantage that might have been gained from this circumstance has been abandoned; rolling the pontoons having been found to injure them so much as to render it impracticable.

The great disadvantage of the cylindrical form of pontoon is, that the bridge constructed with this kind of vessel is so wanting in stability and so liable to violent oscillation from side to side, as well as to rapid undulations in the direction of its length, as to occasion doubts in the minds of many able officers whether it could ever safely be employed on a campaign: as yet the cylinder is totally untried on active service, and at almost the only approach which has been made to such trial, viz. in the passage of the Thames at Chobham, the failure of this pontoon to form a serviceable bridge was complete, and resulted in the capsizing overboard of a 6-pounder gun with several men and horses; the loss of life, which might have been serious, being fortunately confined to the drowning of two artillery horses.

It has been proposed to remedy this fatal defect by increasing the number of pontoons in a bridge; but this, while adding to the difficulties of transport, will but slightly mitigate the evil, as the motions above alluded to are not caused so much by any want of buoyancy as by the form of the pontoon itself.

Both motions are caused by the sudden immersions and risings to which the cylinder is subject, the oscillations by the ends of the cylinder being alternately depressed, and the undulations by the entire cylinders successively undergoing the same movement, from the transit of heavy bodies over the bridge.

This tendency of all round-bottomed pontoons to sudden immersions is,

as I mentioned above, entirely the result of their form, which does not give a good foundation as it were on the water. A builder in constructing the foundation of a house secures stability by spreading it out as flat and as wide as possible, and the more yielding the soil the wider he is obliged to spread it; surely then when we come to the most yielding of all substance on which we can build a foundation we ought not to act in direct opposition to this self-evident rule.

Again take the case of the bow of a boat: would any one ever for a moment expect a square-bowed or box-ended vessel to move as fast as one whose bow was more or less rounded in form? Now as it would be infinitely more difficult to force a flat end through the water horizontally, so does the rule apply to forcing a body downwards into the water; and from all these considerations it is plain that to get a stable foundation for a pontoon bridge we must have a flat-bottomed vessel to begin from.

A second cause for the sudden vertical motion of the cylindrical pontoon is from the fact of its increase of buoyancy being so rapidly lessened after the axis has been immersed, as can be readily seen from a moment's consideration of the table of immersions.

To lessen the amount of oscillation it has been necessary to make the cylindrical pontoon of such a length as to be very inconvenient on land transport; this, though of less importance on a turnpike road, becomes serious across country, a fact, I believe, that was also discovered at the Chobham campaign, when in crossing some rough country the fore end of the pontoon actually struck the wheel-horse on the back and obliged the driver to dismount rather rapidly to save his own head and back.

The last defect that I have to notice in the service-pattern pontoon is the material of which it is constructed, viz. the common tin (that is, sheet-iron tinned) of commerce, and which is liable to constant accident from defective joints and from corrosion; the most fatal being the unseen internal decay, which commences almost with the first time that a pontoon is put into the water. On transport the mere shaking and jolting of the carriages over rough country are sufficient to strain the soldered joints of the sheets of tin, and in launching from a rocky bank the greatest care and tenderness are requisite to prevent a leak being started: so much has this been felt, that cylindrical pontoons have been constructed of copper, galvanised iron, and also of yellow or Muntz's metal, a species of brass—but with so little success that we have invariably gone back to the tin, defective as it is; the copper is very expensive, so soft that a blow of a boat-hook will puncture it, and any contact with hard substances causes dents so deep and so permanent that its original form is soon lost; the additional weight of the copper is also considerable, and this objection equally applies to the galvanised iron and the yellow metal.

Before quitting the consideration of close metallic pontoons, it is necessary that we should notice another pontoon of the same class; I allude to that proposed by General Sir Charles Pasley, a lengthened description of which is not however necessary, as it has been lately so ably explained here by the distinguished inventor; but I would merely note that some of the defects of the cylinder seem to be absent from this pontoon. The sides being vertical, the rapid immersion above the axis of the cylinder is avoided. The inside is capable of being got at to a limited

Fig. 1.

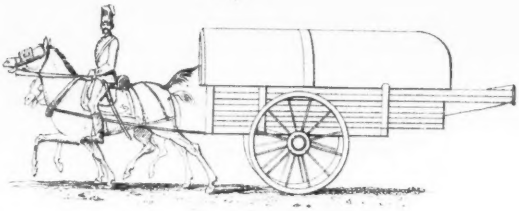
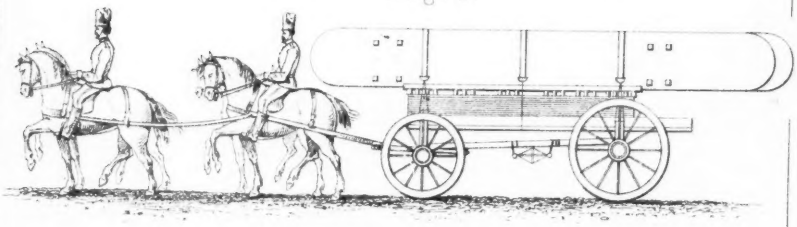


Fig. 2.



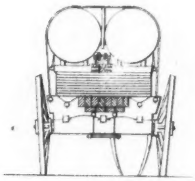
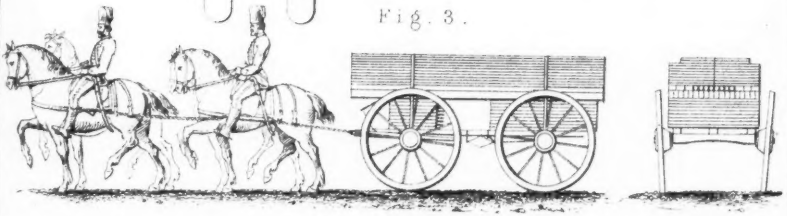


Fig. 3.



extent, and the metal is protected by a keel. The great length of the pontoon on transport is avoided by its being divided in the centre; and copper on wood framing is substituted for tin as the material of which it is made. The narrow, unstable, rounded bottom is however still retained. The division in the centre, which throws an enormous strain on the keel lashing, introduces a new and grave source of weakness. The weight of the pontoon is increased enormously, and, although the weight of a given length of bridge is put down as less than with the cylinder, yet this advantage is only apparent, being obtained by placing the pontoons as far apart as to reduce the buoyancy of the bridge by nearly a quarter.

The method of transporting the pontoons on two-wheeled carriages (Plate II. fig. 1) is uneconomical, as two carriages, weighing together 17 cwt., are employed to carry one raft, which is carried on one carriage of 13 cwt. in the service-pattern bridge. Moreover, in crossing rough country, the jerks that would be caused by the centre of gravity of the load being rapidly shifted to points before and behind the axle would be fatal to any cattle. This last remark does not apply so much to continuous and tolerably regular inclines, up and down which I am aware the two-wheeled carts have travelled, but to a country intersected by ditches and sudden inequalities, over which I should not conceive it to be possible to transport it for any distance.

It must be besides borne in mind that, while in the service-pattern bridge the load drawn by each horse (Plate II. fig. 2) is only 1,200 lbs. or little over half a ton, that imposed upon each of the pair in the two-wheeled cart is one-third more, or 1,600 lbs., a load which it would not be safe to impose upon any one horse on active service.

Let us now take a brief summary of the various points that we have had under consideration, and we find—

That the continental flat-bottomed boat is almost every thing that could be desired as a substructure for a pontoon bridge, its only defect being the want of a deck.

That on land however it is heavy and difficult of transport.

On the other hand we find that the cylindrical pontoon has the advantage of greater lightness and portability, but that, with the single exception of its being a close vessel, it is very inferior as a bridge-former.

In the copper canoe, we find that some of the defects of the cylinder are absent, others are mitigated to a greater or less extent; but, as the ameliorations are accompanied by the introduction of fresh drawbacks, while on the whole the gains are trifling, it is a delicate question after all with which of these the balance of advantages would seem to remain, and it is not within the province of this paper to offer any opinion for or against the justice of the decision of that Committee of Officers who pronounced in favour of the cylinder to the exclusion of the copper canoe pontoon.

In both these metallic pontoons so much of the real value of a pontoon appears to be sacrificed and so little is gained in its place, that a great doubt has been raised whether our departure from the practice of continental nations has been really a step in advance. If it were, it is reasonable to suppose that some of the other European powers would have followed us, whereas I believe it will be found to be the opinion of most foreign officers that our pontoon improvements have been but a retrograde

movement, an opinion that is shared by officers in our own service who have devoted themselves to the study of this branch of their profession; and in fact under the head of Pontoon in the *Aide Mémoire* to the military sciences I find it stated as the writer's conviction that a "a perfect pontoon bridge equipment, combining facility of transport with the quick means of passing armies over considerable rivers, does not seem to have been yet organised."

Having laid before you the difficulties of the case, and shewn what have been the various attempts to overcome them, none of which appear to have been very successful, I would now introduce to you a description of pontoon by means of which I hope to be able to shew that a satisfactory solution may at length be arrived at for this confessedly difficult problem.

The pontoon of which we have a representation (Plate III.) belongs to the class of *boat*-pontoons, and much resembles in form the wooden *bateau à ponton* in use in the French service, being flat-bottomed, nearly rectangular in plan, and with straight sides inclined outwards, so that it is rather broader above, or on deck, than at the bottom; the bow and stern (figs. 1, 2, and 4) are alike, and are somewhat similar to the bow of a Thames barge, to which vessel the boat bears a considerable resemblance. It is composed of a wooden skeleton over which is strained stout canvas, rendered waterproof by the application of a waterproofing solution. The skeleton (figs. 1, 4, 6,) consists of a number of transverse frames or ribs, which are kept in their places by two longitudinal stretchers that run through iron loops in the upper part of each frame (figs. 1 and 6), and on withdrawing the stretchers the whole boat is capable of being collapsed like the bellows of an accordion (figs. 2 and 3), the transverse frames being permanently fastened to the canvas envelope.

The end portions of the boat are decked with canvas, and the body part is partially covered by a deck of the same material, having however a narrow hatchway along the centre for the convenience of bailing out or examining the interior of the boat (fig. 4); the hatchway also gives the means of using the pontoon separately as a boat, if desired.

The dimensions of the pontoon are— length 24′, breadth 5′ 0″, depth 2′ 3″, length of the body 16 feet, length of each end 4′ 0″. The transverse frames, of which there are six, are fixed into the canvas at equal distances; over each frame a hoop is laid on the outside of the canvas, and the two are firmly riveted together with copper boat-fastenings (fig. 7). These hoops are half an inch wider than the frames, so as to project a quarter of an inch beyond them in each direction; therefore, on the pontoon being collapsed, the external hoops touch one another and form a continuous wooden case or shell for the protection of the canvas; while, from the frames being narrower, a space of half an inch is left between them, which gives ample room for the canvas to fold in without any danger of being chafed or injured by friction. These frames form the body of the pontoon, the ends decrease in width to 2 feet 6 inches at their extremities, where they terminate in transverse pieces of wood or transoms of that length (figs. 1 and 4). The transom at the stern has two holes in it, and the bow transom

CAPTAIN FOWKE'S PONTOON.

Side Elevation.

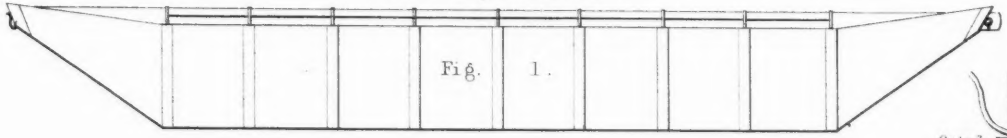


Fig. 1.

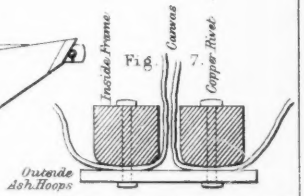


Fig. 7.

Enlarged Section of part of frame shewing provision for preserving the Canvas.

Plan.

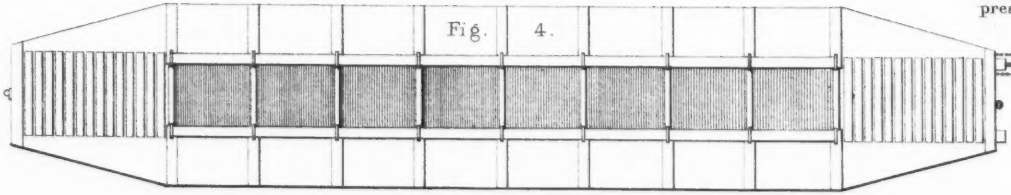
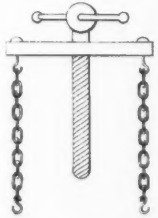


Fig. 4.

Fig. 5.



Screw Jack

Elevation of one frame.

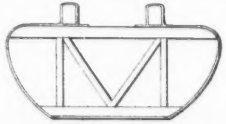


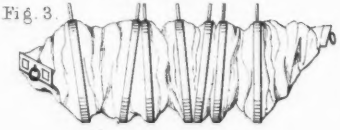
Fig. 6.

Pontoon collapsed.

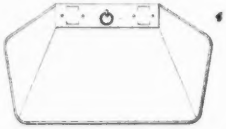
Fig. 2.

Pontoon with stretchers withdrawn.

Fig. 3.



End Elevation.



Scale ¼ Inch to a Foot.

J.R.Jobbins

has mortices or sockets corresponding to these holes. These are for the reception of the stretchers, which are passed through the holes, and, being run through the iron loops in the top of each frame, are directed into the sockets of the bow-transom, and, being pressed firmly home, stretch the pontoon to its proper shape, in which position the stretchers are keyed through the stern transom. A small screw-jack is provided for each waggon, for the purpose of facilitating the operation of stretching (fig. 5).

As mentioned above, the ends are decked with canvas as far as the first frame, and on these decks are sewn thin ash laths, which are amply sufficient to bear the weight of two or more men for the convenience of anchoring, weighing, &c. (fig. 4).

The body of the pontoon is decked along each side up to the stretcher, the canvas being turned up beside the stretcher and forming a sort of combing to the hatchway; and a contrivance is also introduced by which the hatchway can be battened down so as to form a close vessel in the event of bad weather or being obliged to form a bridge in rough water.

By means of a diaphragm of canvas stretched on each frame, the pontoon is divided into watertight compartments, the two end ones forming air-chambers like those of a life-boat. The stretchers serve also for saddles, the baulks being secured to them by means of perpendicular pins passing through both, the holes in the baulk being enlarged into slots on the lower side, so as to give it play in a vertical direction; the baulks are prevented from rising off their pins by the chesses, which are keyed down at each end to the stretchers (fig. 7), with keys of sufficient length to allow of the vertical play of the baulk. The chesses are laid in the ordinary manner. It is proposed to place the pontoons always at a distance apart of ten feet from centre to centre, no closer order being requisite even for heavy artillery.

The method of forming a bridge is either by rafts or by booming out from the shore, the latter operation only differing from the same manœuvre as at present performed, to suit the difference in superstructure.

In Plate II. fig. 3, is shown the method of packing for transport, where three pontoons with their superstructure are carried on each carriage. The carriage is much shorter than the present one, and will probably be somewhat lighter, as the heavy bolsters are no longer necessary; the wheels are all of equal size, and the same as those of a light 6-pounder, thus giving facility for changing or replacing an injured wheel. The draught is lighter, particularly over rough ground, by the front wheels being made larger, and by the axles being brought closer together; and the carriages is also capable of locking round as easily as that of a field-piece.

Here then we have at once a pontoon similar in form to the best continental patterns, a flat bottom for stability and sides sloping outwards, so that any wash or surge is thrown off, and also that the buoyancy increases rapidly as the pontoon is immersed, while the continental defect of want of deck is also remedied by the canvas deck above described.

If we have not then fallen into the error of the foreign pontoon, viz.: want of portability, we shall have at once a heavy balance of advantages on the side of our canvass boat. Let us then compare the canvas with the metallic pontoons as to their buoyancy, weight, and bulk for travelling;

and first, as to buoyancy, in Plate IV. figs. 1, 2, and 3, we have immersions of the three pontoons when loaded equally, from which you will see that, while the cylinder is totally *hors de combat*, and the canoe can only just keep its head above water, the canvas boat is riding easily with plenty of buoyancy to spare.

Next, as to weight, we find that the weights of the three pontoons when packed for travelling are as follow: tin cylinder 5 cwt., canoe 8 cwt., canvas 2½ cwt.; and the relative bulk of the three when ready for transport, as given in Plate IV. figs 4, 5, and 6, will show the advantage which the canvas has over either of the others in this most important particular.

It is thus quite clear that the gain over the metallic pontoon in stability, buoyancy, lightness, and portability is very great; and indeed, if you will just remember the list of advantages that were claimed for each of those vessels, you will find that there is not a single one in which they are not surpassed by the canvas boat—while the whole of the disadvantages are avoided.

Thus the canvas boat can be bailed out, inspected, and repaired without even withdrawing it from its place in the bridge.

The canvas-boat pontoon is capable of being used and pulled as a boat, and each is perfectly stable by itself; it may be pulled or poled into its place in the bridge without being made into a raft.

The boat is divided into seven watertight compartments, and is thus equal to the cylinder in this respect. A glance at the diagram (Plate IV. fig. 3), will show that the boat will give a higher roadway under heavy loads than the cylinder.

So much for the pontoons individually. The positions which they respectively occupy in the bridge are shown in the diagram (Plate IV. figs. 7, 8, 9), in which a hundred feet in length of heavy artillery bridge are shown as formed of each of the three kinds of pontoon under consideration, the cylinders being placed 8 feet apart from centre to centre, the copper canoe 12 feet 6 inches, and the canvas boats 10 feet apart.

The difference in the buoyancy of the entire bridge may be seen at a glance, the proportions being—

	lbs.
Canoe . . .	70,000
Cylinder . . .	90,000
Canvas . . .	130,000

The method of transport and comparative portability of the three systems of bridge are shown in the Plate II., where we have in the case of the canoe, one two-wheeled cart drawn by two horses carrying 12½ feet of bridge (fig. 1).

With the cylinder a four-wheeled and four-horsed waggon carrying 16 feet of bridge (fig. 2).

And with the canvas boat a smaller four-horse waggon carrying 30 feet of bridge (fig. 3). The horses in the two latter cases drawing

Equal Weight upon each.

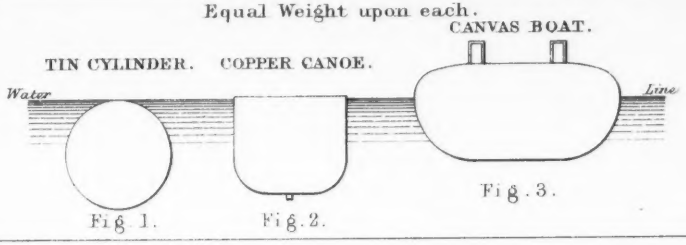


Fig. 1. Fig. 2. Fig. 3.

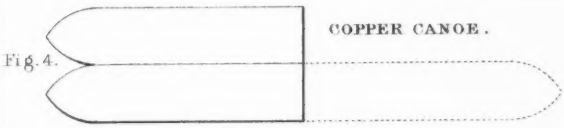
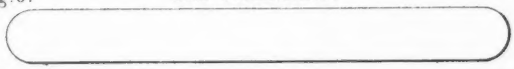


Fig. 4.

Fig. 6

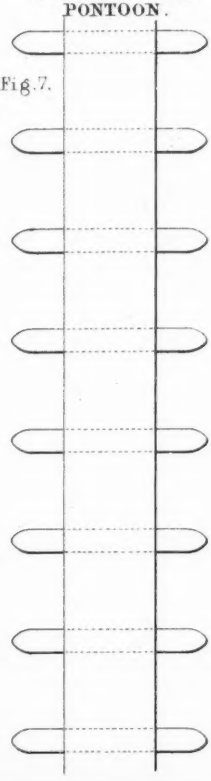
CANVAS BOAT.

Fig. 5.



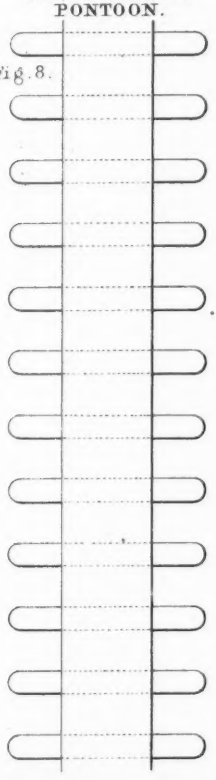
COPPER CANOE PONTOON.

Fig. 7.



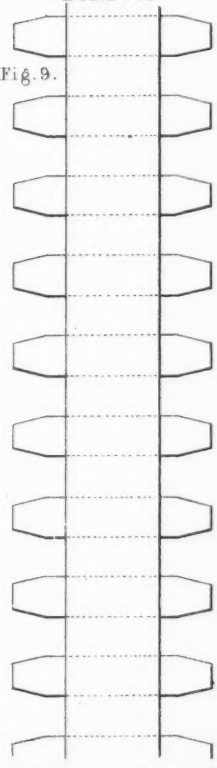
TIN CYLINDER PONTOON.

Fig. 8.

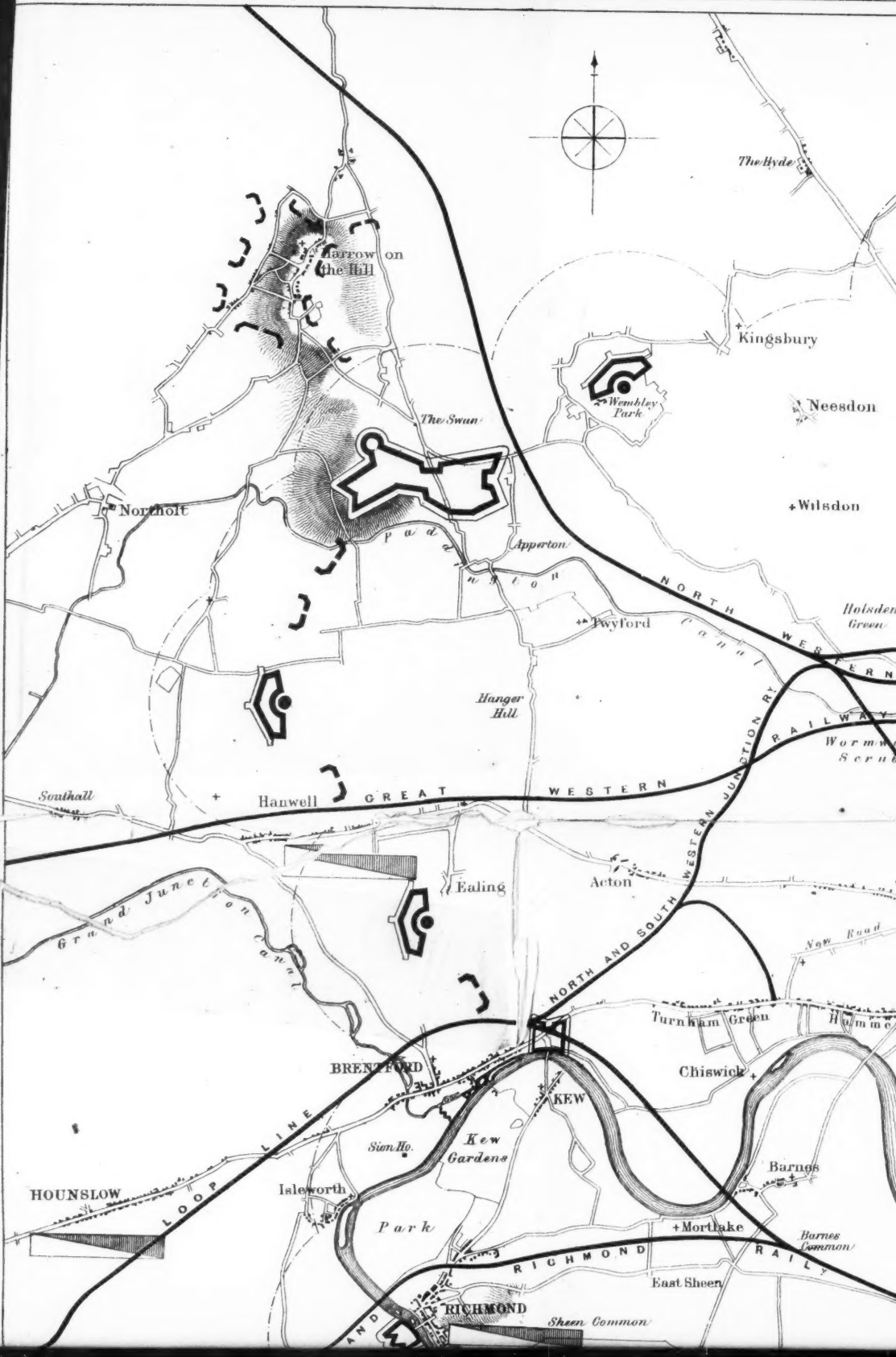


CANVAS BOAT PONTOON.

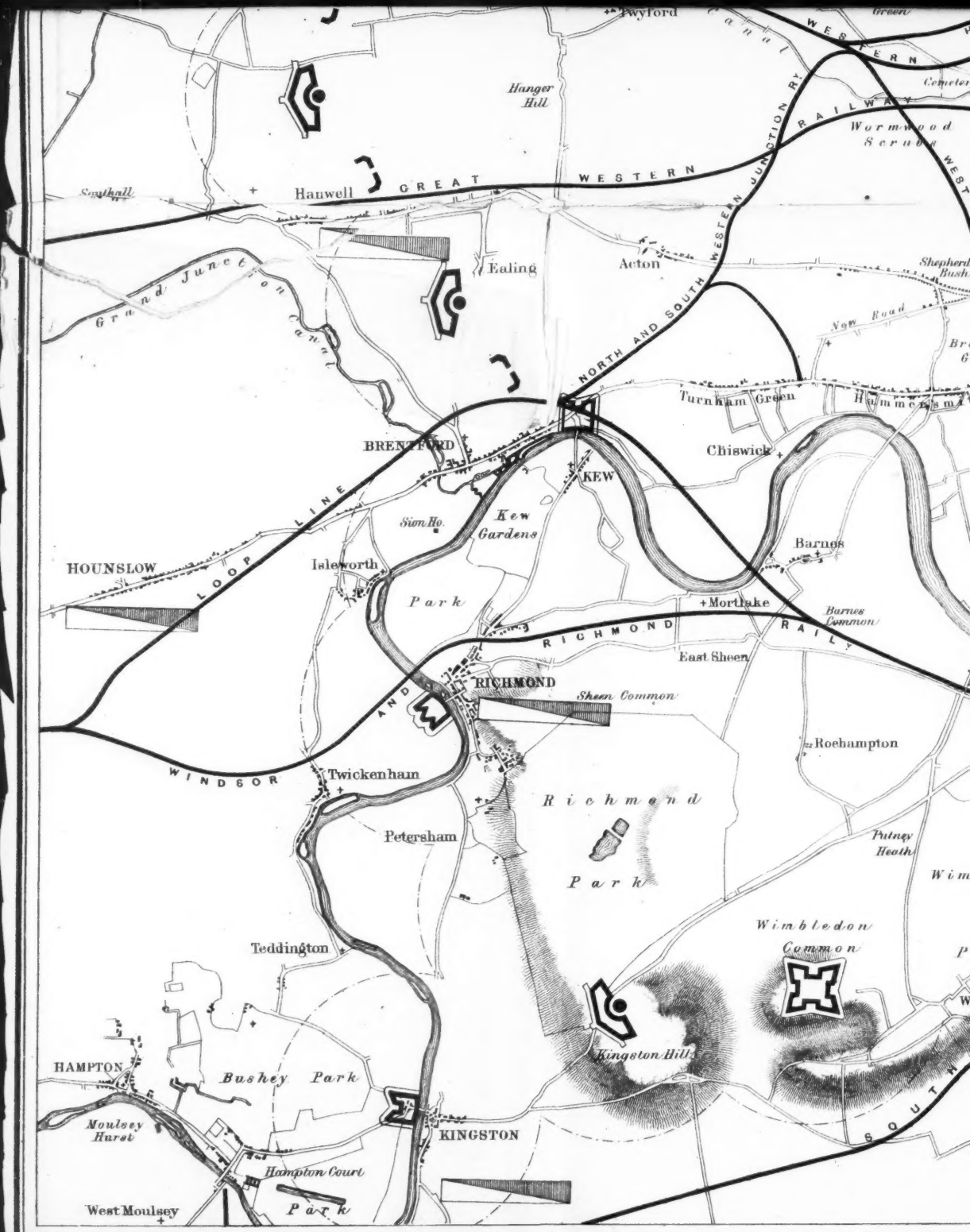
Fig. 9.

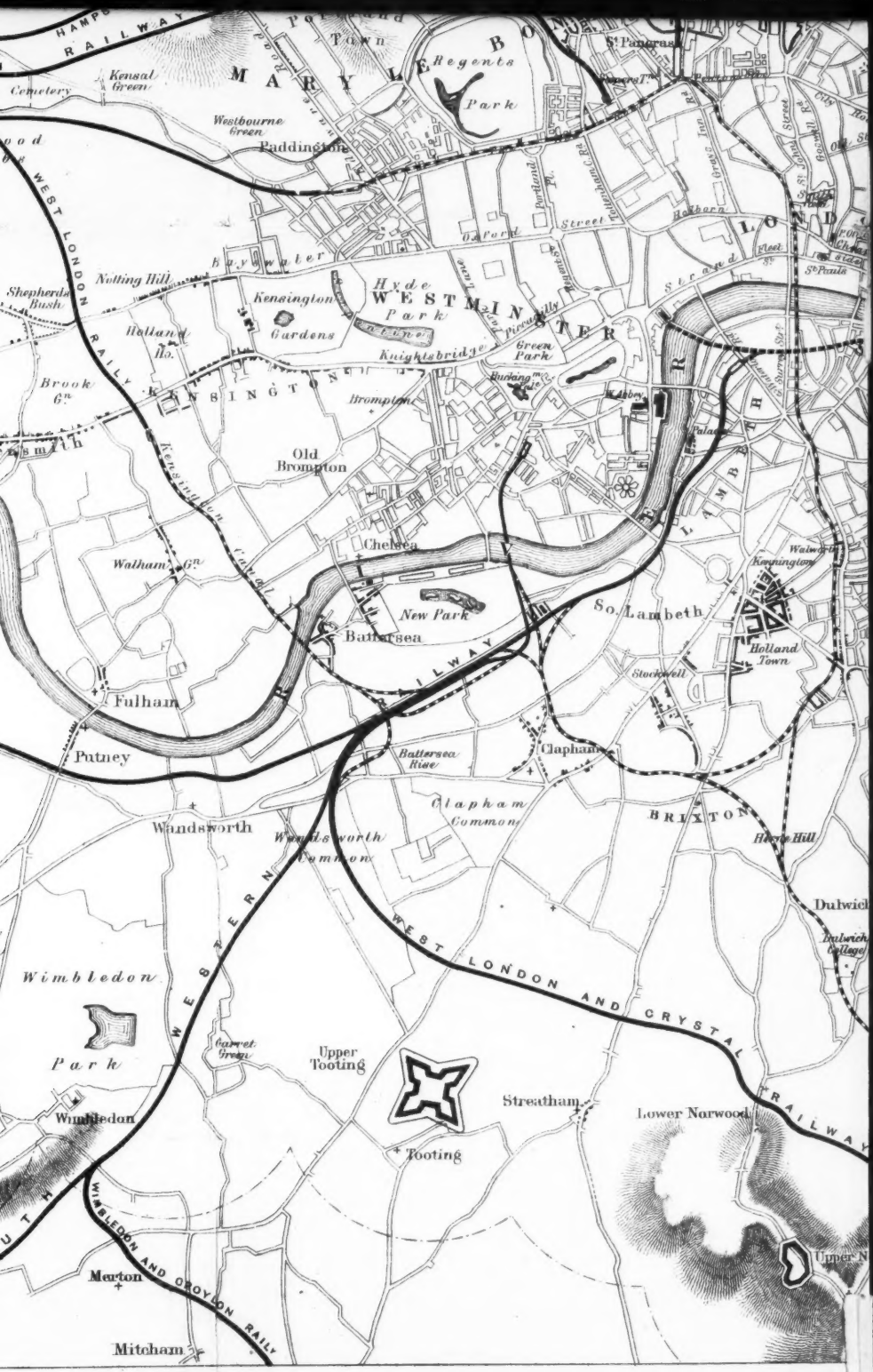


J.R.Johbins


The Hyde
Harrow on the Hill
Kingsbury
Wembley Park
Neesdon
The Swan
Northolt
Wilsdon
Apperton
Pad
NORTH WESTERN
Holsden Green
Twyford
Canal
Hanger Hill
Worm
Scru
Southall
Hanwell
GREAT WESTERN
RAILWAY
Ealing
Acton
Grand Junction Canal
NORTH AND SOUTH WESTERN JUNCTION RY.
New Road
Turnham Green
Ham
BRENTFORD
Chiswick
KEW
Sion Ho.
Kew Gardens
Barnes
HOUNSLOW
LOOP LINE
Isleworth
Park
Mortlake
Barnes Common
RICHMOND
RAILWAY
East Sheen
RICHMOND
Sheen Common

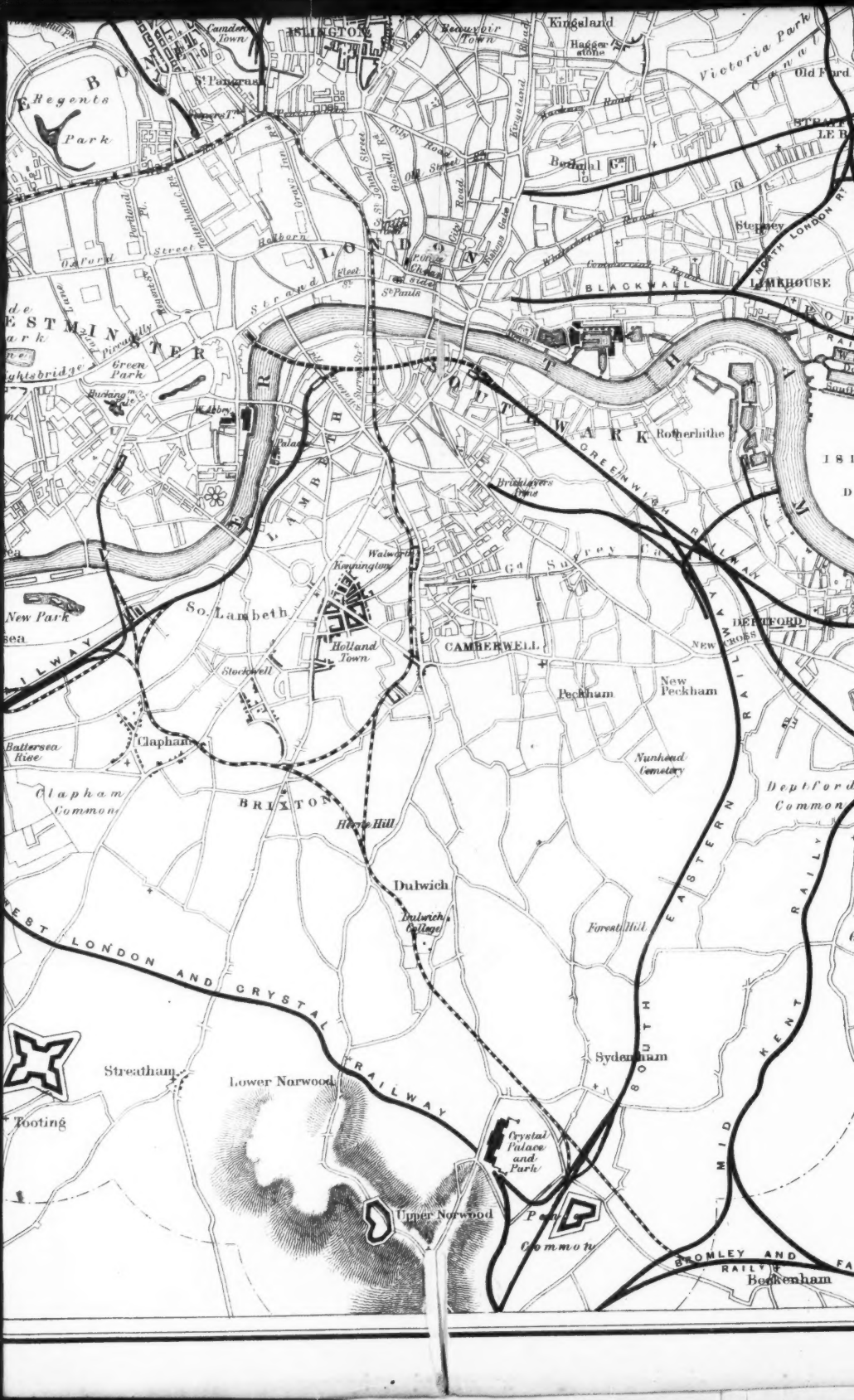
Finchley
Hendon
St Pancras and Islington Cemetery
St Marylebone Cemetery
Bald Faced Stag
Muswell Hill
Wood Green
HORNSEY
Crouch End
Golders Green
HIGHGATE
North End
Hampstead Heath
The Harp
Chalk Hill
HAMPSTEAD
Lower
Holloway
KENTISH TOWN
Highbury
Haverstock Hill
New Cattle Market
ISLINGTON
Kilburn Vale
Holsden Green
Princes Hill Pl.
Camden Town
St Pancras
Portland Town
Regents Park
Kensal Green
Cemetery
Westbourne Green
Paddington
Oxford Street
Holborn
Strand
St Pauls
Notting Hill
Shepherds Bush
Kensington Gardens
Hyde Park
WESTMINSTER
Green Park
Knightsbridge
Brompton
Old Brompton
Chelsea
Walham Gn.
New Park
Battersea
Fulham
Putney
Battersea Rise
Clapham
Clapham
So. Lambeth
Stockwell
Holland Town
Walworth
Kennington
HAMPSTEAD AND CITY JUNCTION RAILWAY
WEST LONDON RAILWAY
NORTHERN RAILWAY
GREAT NORTHERN RAILWAY
METROPOLITAN RAILWAY
Kensington Canal

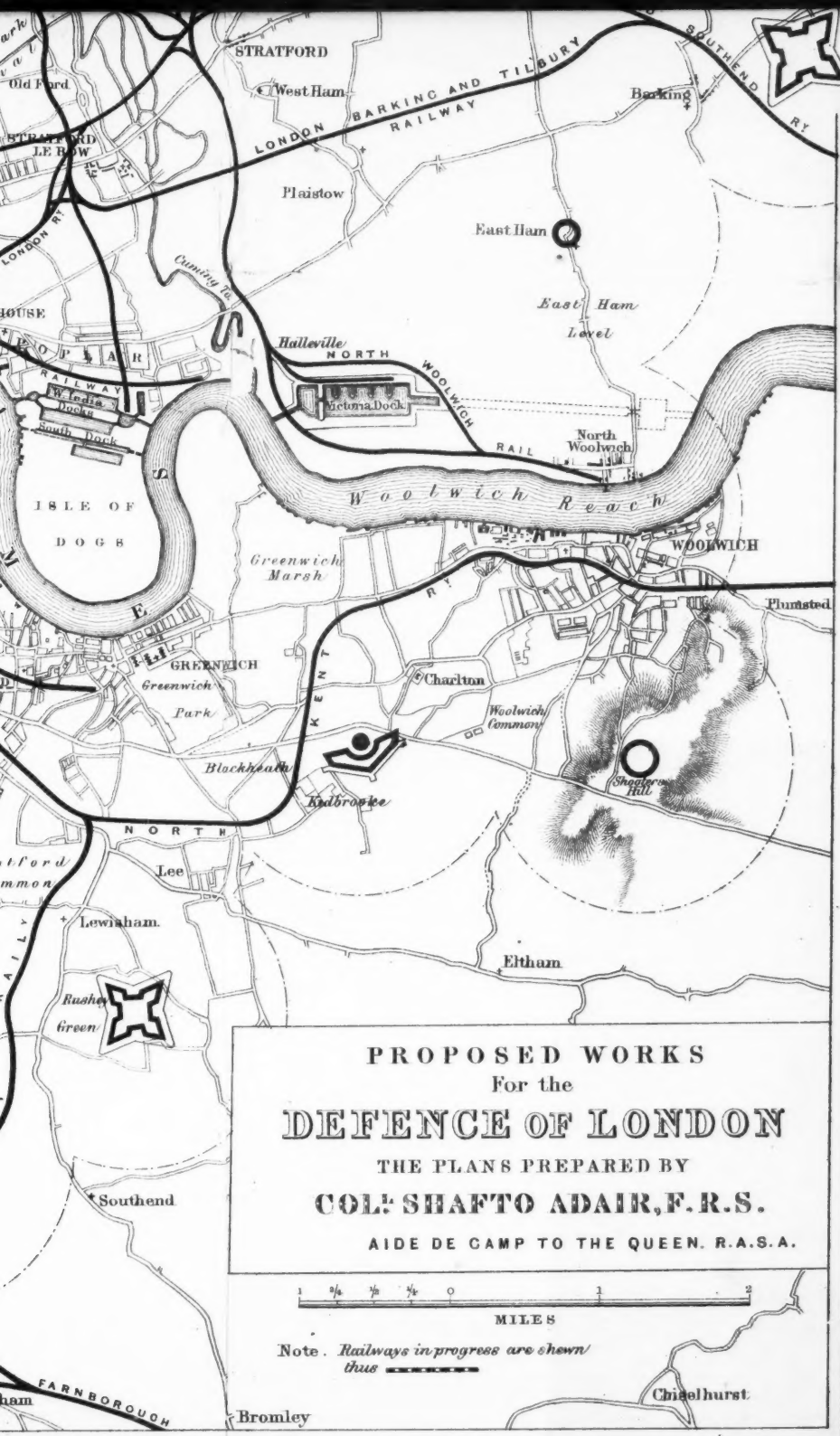

Twyford
Hanger Hill
Wormwood Scrubs
Southall
Hanwell
GREAT WESTERN
Ealing
Acton
Shepherd's Bush
Grand Junction Canal
NORTH AND SOUTH WESTERN JUNCTION RY.
New Road
Turnham Green
BRENTFORD
Chiswick
KEW
Kew Gardens
Sion Ho.
HOUNSLOW
LOOP LINE
Isleworth
Park
Barnes
Mortlake
Barnes Common
RICHMOND RAILWAY
East Sheen
RICHMOND
Sheen Common
Roehampton
WINDSOR AND
Twickenham
Richmond Park
Petersham
Putney Heath
Wimbledon Common
Teddington
HAMPTON
Bushey Park
Moulsey Hurst
KINGSTON
Kingston Hill
Hampton Court
Park
West Moulsey
SOUTH


Kensal Green
Cemetery
Westbourne Green
Paddington
Regents Park
St Pancras
Town
Oxford Street
Holborn
Bayswater
Notting Hill
Shepherds Bush
Kensington Gardens
Hyde Park
WESTMINSTER
Green Park
Knightsbridge
Brompton
Old Brompton
Chelsea
New Park
Battersea
Fulham
Putney
Wandsworth
Wandsworth Common
Clapham
Clapham Common
Stockwell
So. Lambeth
Holland Town
Walworth
Kennington
BRIXTON
Dulwich
Wimbledon
Park
Garret Green
Upper Tooting
Tooting
Streatham
Lower Norwood
Merton
Mitcham
WEST LONDON AND CRYSTAL PALACE RAILWAY
WIMBLEDON AND CROYDON RAILWAY
WEST LONDON RAILWAY
LONDON

Tottenham
Tottenham High Cross
Woods Green
Muswell Hill
Bald Faced Stag
HORNSEY
Crouch End
HIGHGATE
NORTHERN RAILWAY
EASTERN COUNTIES
Upper Clapton
Stoke Newington
West Hackney
E.t Clapton
Lower
KENTISH TOWN
Holloway
Highbury
Newington Gn
LONDON
Dalston
RAILWAY
Homerton
Hampstead Hill
New Cattle Market
NORTH
Bally Pond
HACKNEY
Kingsland
Reservoir
Hagger stone
ISLINGTON
Camden Town
St Pancras
Victoria Park
Regents Park
Pentonville
Penton Pl.
Liverpool St
Bethnal Gn
Stepney
Holborn
Fleet St
St Paul's
BLACKWALL
LONDON
WESTMINSTER
Green Park
Buckingham Pal.
Abbey
Palace
SOUTHWARK
Rotherhithe
Bricklayers Arms
GREENWICH RAILWAY
LAMBETH
Waterloo
Kennington
So. Lambeth
New Park
DEPTFORD

Chapel End
Woodford
Hainhault Forest
Walthamstow
Whips Cross
Epping Forest
Snaresbrook
Wanstead
Leytonstone
Low Leyton
Epping Lower Forest
Great Ilford
EASTERN COUNTIES RAILY
N.W. AND E. COUNTIES JUNC.
TILBURY AND SOUTHEND RY.
STRATFORD
West Ham
Barking
LONDON BARKING AND TILBURY RAILWAY
Old Ford
STRATFORD LE ROW
Plaistow
East Ham
East Ham Level
Halleville
NORTH WOOLWICH RAIL
Victoria Dock
North Woolwich
Woolwich Reach
WOOLWICH
ISLE OF DOGS
Greenwich Marsh
Plumsted
GREENWICH
Greenwich
Charlton


ISLINGTON
Camden Town
Regents Park
St Pancras
Kingsland
Victoria Park
Canal
Old Ford
Stepney
LIMEHOUSE
BLACKWALL
LONDON
Holborn
Oxford Street
Strand
Fleet St
St Pauls
Westminster Abbey
Palace
Green Park
Buckingham Palace
Hyde Park
Kensington
Walworth
Brickmakers Arms
Rotherhithe
SOUTHWARK
LAMBETH
So. Lambeth
New Park
Holland Town
Stockwell
CAMBERWELL
Peckham
New Peckham
Nunhead Cemetery
Battersea Rise
Clapham
Clapham Common
BRIXTON
Herne Hill
Dulwich
Dulwich College
Forest Hill
Deptford Common
DEPTFORD
Streatham
Lower Norwood
Tooting
Crystal Palace and Park
Upper Norwood
Sydenham
Penge Common
Beckenham
WEST LONDON AND CRYSTAL PALACE RAILWAY
SOUTH EASTERN RAILWAY
MID KENT RAILWAY
BRIGHTON RAILWAY
GREENWICH RAILWAY
NORTH LONDON RAILWAY



PROPOSED WORKS
For the
DEFENCE OF LONDON
THE PLANS PREPARED BY
COL.ᴸ SHAFTO ADAIR, F.R.S.
AIDE DE CAMP TO THE QUEEN. R.A.S.A.

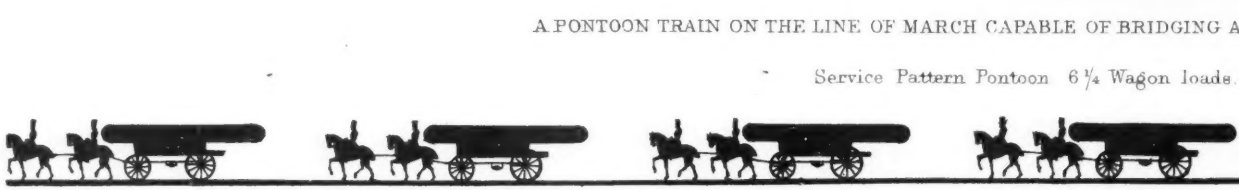
1 ¾ ½ ¼ 0 1 2
MILES

Note. *Railways in progress are shewn thus* ------

J.R.Jobbins

A PONTOON TRAIN ON THE LINE OF MARCH CAPABLE OF BRIDGING A

Service Pattern Pontoon 6¼ Wagon loads.



Copper Canoe 8 Cart loads.

Canvas Boat Pontoon 3⅓ Wagon loads.

GING A RIVER 100 FEET WIDE.

loads.

J.R.Jobbins.

little more than half a ton each, while with the canoe they are loaded with nearly three-quarters of a ton each, and the wheel-horse has the whole jerk and wear of nearly one and a half tons on his back, which in a rough country it is quite impossible that one horse could bear.

Some idea may be formed of the superior portability of the canvas pontoon bridge from the accompanying diagram (Plate V.), where the quantity of bridge equipment necessary for the passage of a stream 100 feet wide according to each of the systems under consideration is shown on the line of march of an army, and from which it appears that while the cylinder requires six and a quarter waggons, and the canoe eight carts, the canvas-boat bridge is carried on rather more than three four-wheeled waggons.

The line of march is shortened no less than half, which is of itself of great importance, and the number of horses is reduced in the same proportion.

In comparing the three kinds of bridge equipment, I find that there is one point that I had omitted to notice, namely: the difference of superstructure, and here we find that with the tin cylinder four different kinds of pieces are employed.

1. Saddles, being a thing like a ladder.
2. Baulks.
3. Chesses.
4. Outriggers to row with.

The canoe has as many as five pieces.

1. The saddle, which shuts up with a parallel ruler motion very easy to get out of order.
2. The baulk.
3. The chess.
4. The dividers.
5. The outriggers, which are used to row with,

In the canvas-boat bridge we have simply two kinds of pieces in the superstructure.

1. Baulks.
2. Chesses.

The vertical pins of the baulks serving as thole pins for rowing with grummets round the oars.

The superstructure of the bridge is thus simplified to the utmost extent and can in fact be made out of any rough timber with no more tools than a saw and auger.

The canvas pontoon itself could without much difficulty be made in the field, such materials as hoops of casks, canvas, poles, and oil, being almost always procurable.

Of course the first objection that will be made by every one to this pontoon will be that no dependence can be placed in a vessel

constructed of so frail and flimsy a material, and this has already been made in the extremely favorable official report which I will now read :—

(*Copy.*)

Royal Engineer Establishment, Chatham,
10th August, 1855.

SIR,

With reference to yours of the 9th inst. requesting a reply to the communication of the 21st December, relative to Captain Fowke's canvas boats to be made at Chatham for trial, I have to report, that, after considerable delay on account of the waterproof composition with which they are paid over, they were completed on the 19th July, 1855, and that Captain Fowke came to Chatham on the 31st July to see them put together and launched.

They were folded and carried to the river in a hand-cart, and then distended in about five minutes, and were launched by eight men; they were then formed into bridge and broken up into raft, and their buoyancy and strength were tested by placing a 32-pounder upon it and increasing it up to 91 cwt. which it sustained perfectly, the gunnels being still ten inches above the water. In one or two places the seams under the great pressure leaked a little, which will probably be completely remedied by another coating of waterproof composition.

In the bridge they were very stiff, and were evidently capable of being formed at a more extended order than the length of baulk Captain Fowke has fixed upon (for the sake of transport) admits of: from the length of bearing of the baulks they are evidently much more buoyant than is necessary, which is proved by the ease with which the raft bore 91 cwt.

Their capabilities of rowing were tested both in raft and as single boats, and it was found impossible to row either of them against the tide,* owing to their extreme lightness and buoyancy, which gave them so little hold upon the water, and it was only by towing them from the shore that the raft could regain the Hard from which they started.

The material with which they are covered is not of a nature to warrant their being placed in a bridge which would be likely to remain any considerable time in the water, but from their compactness in packing and their lightness they might be of great advantage in advanced and desultory operations.

I have, &c.,

Signed, H. SANDHAM,
Col. Royal Engineers.

The Inspector General of Fortifications.

But, before committing ourselves to such an assertion, let us examine this flimsy material, of which I have here a sample, and see if it be really so inferior to tin and copper. Suppose we take a square yard of each of these materials and stretch them out, confining them at the edges (and remember that in the square yard they must all have joints, and that in metal, joints are a source of weakness, while in canvas they are frequently introduced for the sole purpose of strengthening it). Now if we put a heavy sledge-hammer into a man's hands, and ask him to send it through the three you can in a moment divine the result, the soldered joints of the tin will

* The rowing here alluded to was not only against tide, but against what would almost be called a gale of wind, and at that time no special provision had been made for rowing. An arrangement has now been made, by which the rafts of pontoons have been successfully propelled against a very strong breeze.—F. F.

be wrenched asunder, the soft copper will be knocked into a hole, but the yielding and elastic canvas would defy the efforts of any one to injure it. But you will say it is not so much a blow as the effect of friction or chafing that you have to dread for the canvas—true; but to render the chafing most effectual it is necessary that the canvas should be supported at one side and rubbed or bruised at the other. Now if you examine the frame of this pontoon you will see that this is guarded against, and that in every place where the canvas is in contact with the frame on one side, it is invariably covered by a protecting hoop on the other.

You will observe also that, along the sides where there is the greatest likelihood of injury from collision, the frame is as elastic as a carriage-spring, it is in fact its own buffer, the stiffness and strength of the skeleton being gained in the interior, where the weight of the bridge is borne, directly by well-framed tressles which are perfectly sheltered from all chance of injury.

An attempt has been made to remedy the want of portability of pontoons by substituting an india-rubber inflated bag, which was employed with considerable success in some minor operations at the Cape in 1848; its advantages are lightness and portability, but I think it will not be difficult to shew that, while the canvas pontoon is superior to the india-rubber one in other respects, it also far surpasses it in those very qualities for which the latter has received so much praise from its numerous admirers.

First take the weight of the two pontoons when packed for transport:

India-rubber,* 413 lbs. Canvas, 260 lbs.

Second, the bulk of the two pontoons when packed for transport—in cubic feet:

India-rubber, 17½ cubic feet. Canvas, 15½ cubic feet.

Third, the ultimate buoyancy of the pontoons—in pounds:

India-rubber, 8,127 lbs. Canvas, 10,974 lbs.

From this comparison it would seem that in these particulars in which the india-rubber pontoon is superior to the present one it is surpassed by the canvas one; besides which, the latter is free from many of the defects to which the india-rubber is liable. Thus the india-rubber is so delicate as to require to be packed in a case. The slightest puncture is fatal to it, which, in the case of the canvas, would only cause an inconsiderable leak. It has to be kept air-tight instead of merely water-tight. It is dependent on its inflation by air for its form, consequently on receiving the smallest wound either above or below water, it will collapse.

There will always be a considerable delay inunpacking and inflating. The india-rubber is much affected by temperature, becoming almost unmanageable from extreme cold, and after exposure for any length of time it loses all the properties of india-rubber, and becomes extremely weak and easily torn and broken.

* The india-rubber pontoon weighs 260lbs, and its packing-case 153lbs.—Total 413lbs. —F. F.

The cost is not stated in the description of this pontoon, but, judging from that of india-rubber goods generally, it cannot, if well made, be much less than four or five times that of the canvas one.

Of the many varieties of pontoons which have at different times been brought forward it will not be necessary to speak in this paper, the merits and demerits of all of them having been so frequently discussed in relation to the present service pontoon, which has here been taken as the standard of comparison.

We have seen, as you may remember, that the Russians have a pontoon of waterproof canvas. They first used it in 1807 when they successfully made several passages of rivers with it; they still employ this pontoon, and I have a letter from a distinguished officer, who has seen and studied much of foreign armies, in which he says, "The Russians have a canvas pontoon which they are very fond of." So, as it has stood the test of more than half a century's experience, it would appear that, after all, there may be something in this flimsy material.

I may give another instance of the employment of canvas as a boat covering. On our wildest and most unsheltered coast, exposed to the full swell of the Atlantic, the Galway fishermen are in the habit of going out long distances to sea in their long row-boats, which are formed of a skeleton of wood covered with either canvas or hides, and they hold the opinion that such a boat is more seaworthy than a wooden one, from the fact of its elasticity in a rough sea.

Sir Howard Douglas mentions that, in India, boats for military purposes have been successfully constructed of hides stretched over a framework of bamboos, and strongly advocates the employment of basket-boats for such purposes.

I may be perhaps allowed to give my personal experience with canvas boats. I have at different times possessed three canvas boats, all of which I constructed myself, and I can safely say that I have often exposed them to injury by running on rocks and piles which would have been fatal to a wooden boat, and that I never met with the slightest accident in one of them.

I am sure that the idea of canvas being more liable to injury is a most mistaken one, but if injured it is infinitely more easily repaired. If a tin pontoon spring a leak you are only made sensible of the fact by finding it gradually disappearing from under you; you have no means of knowing the position or character of the injury, and the only thing you can do is to break the bridge, thus stopping all communication, get the pontoon (which must be lashed to its fellow) to shore, light a fire and set a tinker or two at work, who will probably make a day's job of it; while with the canvas boat you can constantly inspect the interior, and in case of a leak you have only to send a man in to find out its situation, when a little pitch-plaster will remedy it *pro tem.*, and the regimental tailor will set it to rights in ten minutes on the first opportunity.

The lightness of the canvas pontoon would moreover admit of a complete extra set of pontoons being carried without even then bringing up the number of waggons to that necessary for the transport of either of the others, and thus you could afford to have one relief of pontoons always

in hospital, and another fit for duty; and, as a canvas pontoon is not half the cost of one of the others, there could be no objection on that score.

I know that it will be urged by some of the admirers of the metallic pontoon that the canvas boat will not row so well as either the tin or the canoe, to this I would answer that there is no difficulty in making a perfectly good and fast boat with canvas, but at present our business is with pontoons; if we try to make one thing do the work of two, we shall probably arrive at the usual result of such contrivances, viz.: that it will do neither well, and the end will be that we shall spoil a good pontoon to make a bad boat.

It seems to be doubtful whether the quality of rowing has not been for some time very much over-rated in value in our pontoon service; at Chatham it certainly has its advantages in providing healthy exercise for the men and producing a pleasing effect on a field-day, and its value is perhaps greater in home campaigns than in actual warfare. In order, however, that the canvas boat bridge should be efficient in this respect also, I propose that for every five waggons of bridge there should follow one boat-carriage which would carry five boats of this model, viz.: a whale boat 34 feet long by 6 feet beam, pulling twelve oars, with water-tight bulk-heads up to the thwarts, and with an air vessel at each end, capable of sustaining fifteen or twenty men in case of accident to the boat. Thus to every three pontoons there would be one full-sized ship's life-boat which could live in almost any weather, which in case of emergency could supply the space of a spare pontoon to the bridge, and which would not only free the canvas pontoon bridge from the charge of want of power of locomotion, but would place it in this particular far beyond any former pontoon bridge that has ever been constructed.

If then, as I hope, I have been able to shew that we have the power of constructing a pontoon that shall be so superior to that now in use in our service, that

1. Its buoyancy is nearly double;
2. Its weight little more than half;
3. Its bulk for transport only a seventh;
4. Its superstructure greatly simplified;
5. The length of its bridge on the line of march less than half;
6. The number of horses reduced in like proportion;
7. That it is accompanied by a life-boat to every three pontoons;
8. That the cost is reduced considerably;

and if with all these advantages we have likewise succeeded in retaining the almost perfect stability and bridge-forming qualities of the *bateau à ponton*, I think we may fairly be said to have made an attempt in advance towards the perfect pontoon equipment which is sighed for by the writer in the *Aide Mémoire* above alluded to.

I shall conclude by telling you that the War Department have appropriated a sum of money for the trial, on a considerable scale, of the canvas pontoon, that several of them are now being constructed under my super-

intendence, and that before the summer practice is over I am in hopes that we shall be able to report some progress towards the attainment of this military philosophers' stone, a perfect pontoon bridge equipment.*

* The pontoons here alluded to have now been constructed; and in a trial which took place in presence of H.R.H. the Commander-in-Chief, both pontoons and life-boat have fully come up to the estimate that is here made of their powers, both as to portability, buoyancy, steadiness, and stability when in a bridge.—F. F.

Friday, May 11th, 1860.

General Sir J. F. BURGOYNE, Bart. R.E. G.C.B. in the Chair.

THE DEFENCES OF PORTSMOUTH.*

By Colonel SHAFTO ADAIR, F.R.S.

A.D.C. to the Queen.

There are special difficulties incident to the treatment of strategic questions as applicable to England, arising from the character of her people, and from the character of her wars. The English mind has great difficulty in admitting the assumption that battles might be fought in the course of events on English ground, although forts and works of defence indicate such a possibility. Secondly, in the interval between the Peninsular War and the first Scinde Campaign, though England was rarely at peace, no war of strategy was undertaken. Probably the largest school of experience is to be found in the operations consequent on the Indian Mutiny. The system of concentration of columns on the positions of the mutineers, in order to crush the rebel forces after the capture of Lucknow, is a magnificent object of study.

Rationale of Defence.

There are five principal points to be considered—

First. Whether any and what portion of the national defence shall be assigned to fortresses or permanent works of the first class.

Secondly. Whether these works shall be treated as substantive and isolated points of resistance, or as points of appui in strategic plans and for tactical movements.

Thirdly. Whether the regular Army is competent in numerical strength to the service required.

Fourthly. Whether the Militia, that is, the Army of Reserve, the Yeomanry, and Pensioners, can be made available. And

Fifthly. Whether the defensive system can be so composed as to include the service of a volunteer auxiliary force—Infantry, Cavalry, Artillery with Engineers, and Boat squadrons.

Let it, then, be assumed that England must have a special military system for home defence. And in this should be utilized the sedentary

* The district map referred to in the Lecture has not been published, to avoid great increase to the size of the publication, but it is hoped that the details given in the Appendix will enable the reader to follow the plan.

portion of the national forces. And, to suit the defensive character of her strategy, as well as to compensate for paucity of numbers and lack of practical experience, the system must be largely based on the advantages to be derived from fortified positions, whether permanent or field. Hence it may be assumed that the defence of fortresses of the first class must be entrusted to the regular forces, and that of the field works to those of the second class—to the Army of Reserve and the local forces.

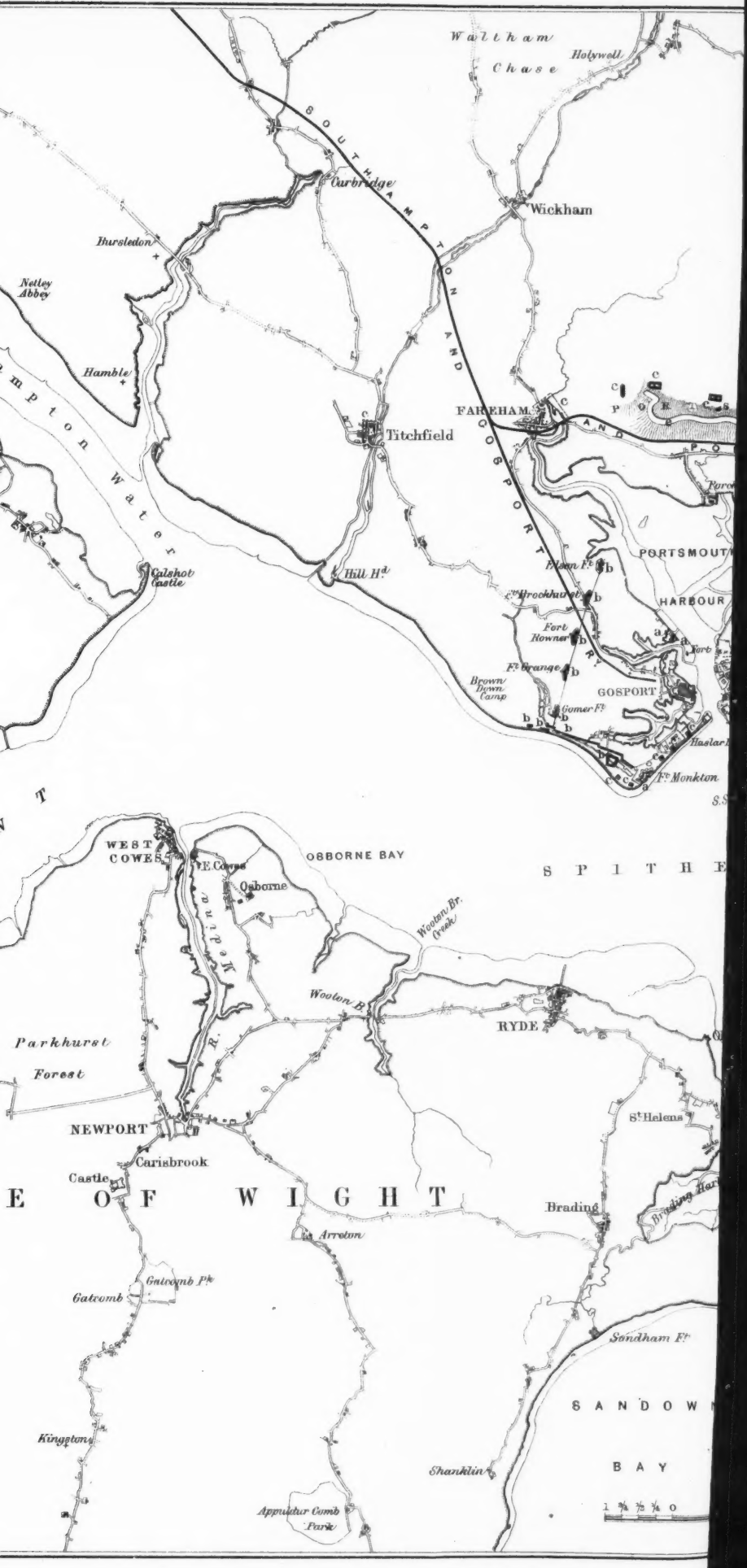
Now as regards the nature of English works of the last 150 years—from the time when the feudal castle or military blockhouse of Henry VIII.'s construction became obsolete—the most noteworthy quality is the low power of defence, combined with large capacity for garrison and stores. As at Landguard Fort, every work had the pretensions of a fort; and every fortified town, of a fortress, as on the lines of Portsmouth. The model afforded by the bastioned villages of the Flemish frontiers was faithfully copied by the Engineers who had been present at the sieges of the wars of William and of Marlborough. But the English defensive work, redoubts, forts, or fortress, should represent the keep of a camp of manœuvre.

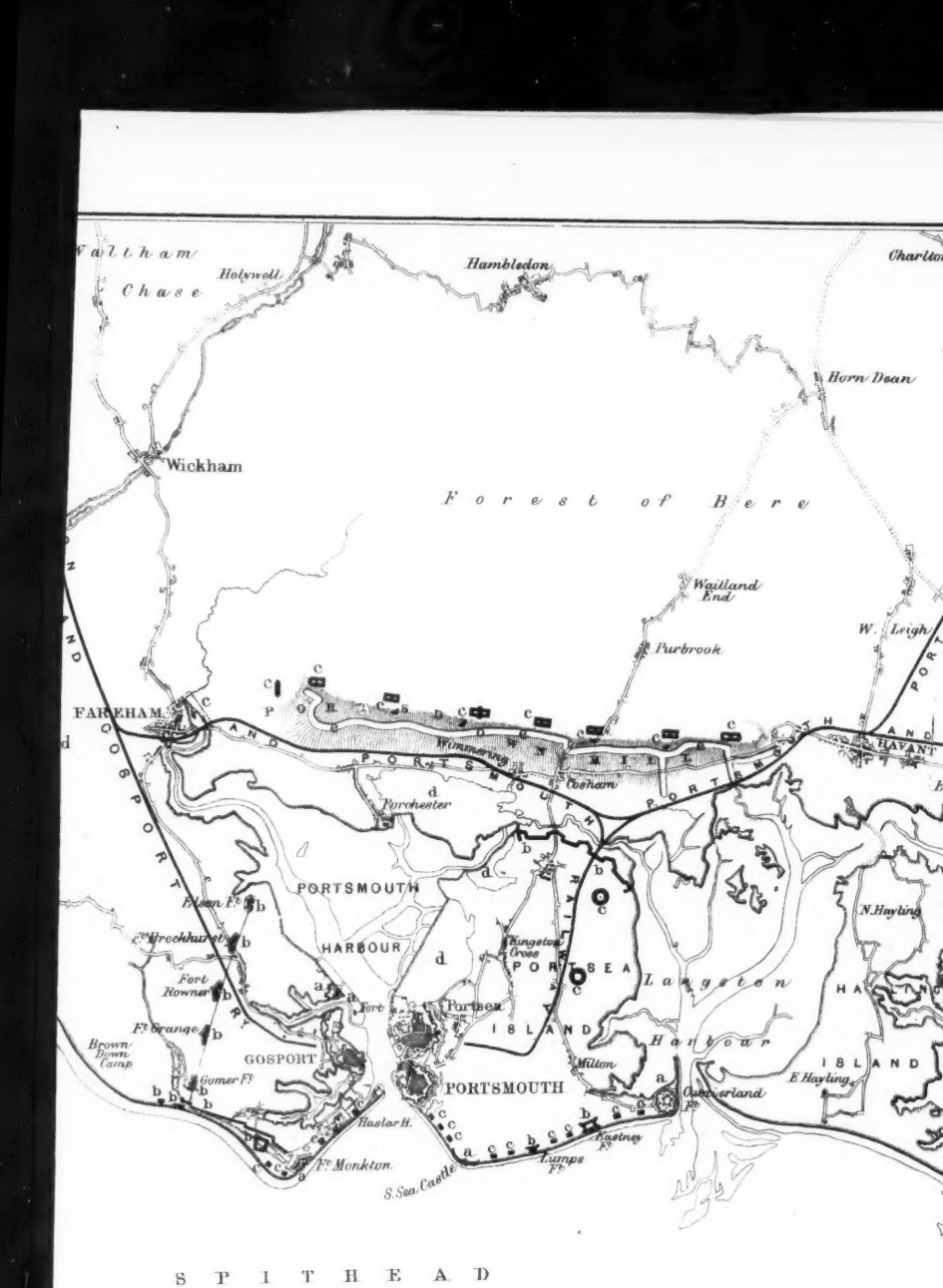
I proceed, with the sanction of H.R.H. the General Commanding-in-Chief, and the permission of the COUNCIL, to consider the conditions under which the defence of Portsmouth may be conducted, either as the site of an arsenal and dockyard, as a maritime fortress, or as a land fortress of the first class, with its dependent positions and entrenched camp; and also as furnishing a base of operations in the event of invasion. I propose, however, to omit all means of defence depending on the Naval departments in activity.

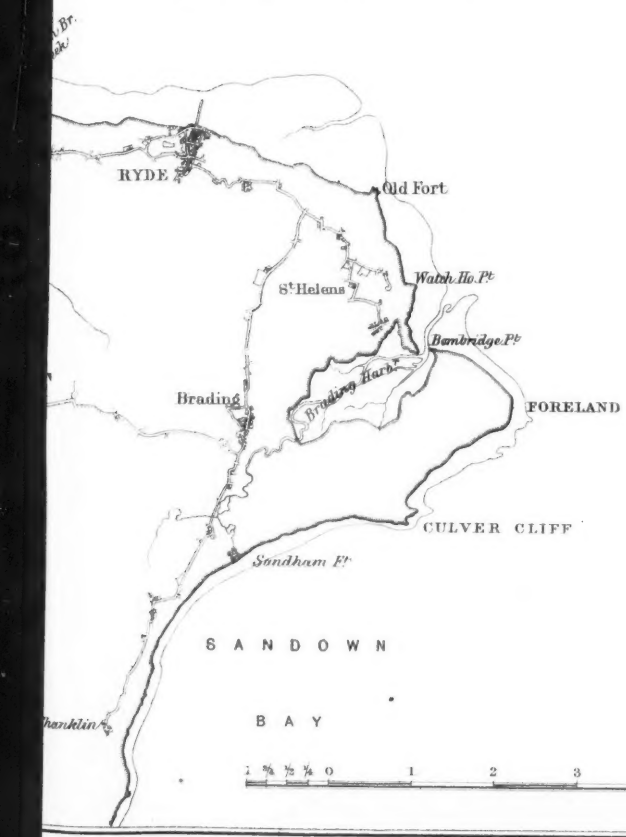
First. With regard to Portsmouth as the site of an arsenal and dockyard.

On referring to the map it will be seen that if a line be drawn from Fort Monckton, at the western angle of the outer harbour, or roadstead, to Southsea Castle on the eastern, as a base, and thence, on either shore, to the Block House Fort, the point where the gorge narrows and the harbour is entered, as the apex, an isosceles triangle will be described, of which the sea-base = 3,500 yards, and the sides = 2,300. Outside, and almost parallel with the base of this triangle, the fair way lies from the westward, till arriving at a point nearly opposite Southsea Castle it joins the passage by the Nab Light, from the eastward, which forms an obtuse angle with the direct passage into the inner harbour, passing under the sea-face of the lines of Portsmouth proper. This triangle lies in-shore of one of the chief anchorages of the empire; wherefore great care has been taken, at all periods, from the time of Edward VI., to secure the anchorage from occupation, and the sea-face of the works from close attack. Now, although it would appear on the first inspection easy to make the inner harbour at any time of tide, yet the channel is tortuous and exceedingly difficult of entrance and exit at times, and always inaccessible to heavy vessels with their lower deck guns in. With regard to the protection which is given by landworks, two forts at the gorge, namely, the Block House Fort and the Point Battery, project their fire athwart the channel. Fort Monckton with its guns sweeps the anchorage at Spithead, and Southsea Castle brings to bear a diverging

SOUTHAMPTON & DORCHESTER RAILWAY
Redbridge
Redbridge
Eling
SOUTHAMPTON
Railway Stat.n
Union Ho.
NEW FOREST
Netley Abbey
Southampt
Hythe
Beaulieu Heath
Cadnam Park
Beaulieu
Exbury
St. Leonards
LYMINGTON
Lymington Riv.
THE SOLENT
Newtown R.
Hurst Castle
YARMOUTH
Victoria Pt.
Cliff End Pt.
Freshwater
Shalfleet
ISLE
FRESHWATER BAY
Brixton Down
Brixton
BRIXTON BAY


Waltham Chase
Holywell
SOUTHAMPTON AND GOSPORT R.
Curbridge
Wickham
Bursledon
Netley Abbey
Hamble
Titchfield
FAREHAM
PORTSMOUTH HARBOUR
GOSPORT
Calshot Castle
Hill Hd
Elson Ft
Brockhurst
Fort Rowner
Fort Brange
Brown Down Camp
Gomer Ft
Haslar
Ft Monkton
WEST COWES
E. Cowes
OSBORNE BAY
Osborne
Medina R.
Wooton Br. Creek
Wooton Br.
RYDE
Parkhurst Forest
NEWPORT
Carisbrook Castle
St Helens
Brading
Arreton
Gatcomb Pk
Gatcomb
Sandham Ft
Kingston
Shanklin
Appuldur Comb Park
BAY





PROPOSED

SHEWI

DEFENCES

From Military Drawin

COL.L SHA

Aide de C

E

a.a.a. *Old Fort*

b.b.b. *Works i*

c.c.c. *Addition*

d.d.d. *Ground*

e.e.e. *Sunken*

S C

ED FORTIFICATIONS

EWING ADDITIONAL

S TO PORTSMOUTH

awings made under the Direction of

HAFTO ADAIR F.R.S.

de Camp to the Queen.

1860

Explanation.

Fortifications.

ks in course of Construction.

ditional Works proposed by Col.l Adair.

und to be reclaimed.

ken Road with Parapet.

C A L E.

10 15 Miles

J.R.Jobbins, 3 Warwick Ct Holborn.

fire on the eastern and western passage, which unite at 1,200 yards from its batteries.

It is needless to detail the nature of the armament of these works. Southsea Castle is a work of an old trace, like the forts within the limit of the Cinque Ports. These have been enlarged and strengthened so as best to meet the requirements of warfare, and may be described as being constructed on the same principle as the original works which were enlarged and re-modelled by Vauban and his immediate successors, and not on the pure bastioned trace, or on the polygonal, which obtains so prominently at the present day. The fire of these works sweeps the channel very effectually. Southsea Castle gives an oblique fire on vessels approaching and passing into the inner harbour, but it has been found necessary to supplement its fire by reconstruction of a work on the foundations of the old Lumps Fort, 1,600 yards to the eastward. This work is on the new construction, and will mount 17 heavy guns, sweeping by direct and oblique fire the obtuse angle down which vessels coming from the eastward pass into the inshore channel parallel to the coast line. A similar work is projected between Lumps Fort and Fort Cumberland. The fire from the old works on a bastion trace at Portsmouth is simply perpendicular to the line of passage, and not apparently very effective against steamers; while to judge from the construction, the nature, and command of these works in reference to the immense offensive powers of vessels of war with the present armament, it appears probable that any heavy vessel, well within range of the King's bastion, and the curtain connecting it with the Point Battery, would act with most destructive effect against that portion of the sea line of defence. But a vessel approaching for that purpose, being broadside to the main works of Portsmouth, would, having endured the oblique fire of Southsea Castle and Lumps Fort, be raked by the guns of the Block House Fort, and therein consists the safety of the Channel. It appears then that, so far as direct fire will prevent the ingress of vessels of war, the key of Portsmouth Harbour lies in the Block House Fort.

The question of the shape of embrasure, and of the protection enjoyed by plated vessels, will be considered hereafter.

Now, restricted as every heavy vessel of war must be in the choice of the channel, and exposed during the greater part of her course to a heavy and fatal fire from Block House Fort, it is not very probable that it would be attempted to force the passage of the inner harbour by the unassisted broadsides of line-of-battle ships or heavy frigates. I leave the question of the accuracy with which guns can be trained from the decks of vessels under steam, so perfectly manageable as they must be, to professional discussion. But one point should be noticed which has not yet been brought prominently forward in respect to the defences of Portsmouth Harbour. The approach of vessels of war, of the heaviest class, is restricted by the circumstances of the tortuous channel delaying their course, while their huge bulk is exposed to the fire of the forts. But there is another element of attack which might be developed in aid, and would exercise a very material effect on the fortunes of the day: I speak of those formidable and minute batteries of movement, gun-boats. I class among gun-boats every steamer that is

restricted to the use of one or two guns. With the experience of the last war to guide us, it is probable that in any attack on Portsmouth, not made solely for purposes of destruction by vertical fire from long ranges, gun-boats would be brought up, and materially assist, in accordance with the system of nautical tactics, which in many cases prefers the fire of accumulated gun-boats to the heavy battery of a man-of-war. Now, a gun-boat engages a battery ordinarily at great advantage. If the Block House Fort or Point Battery be attacked, on the prolongation of the capital, that is, perpendicular to the face of the work, the loss caused by enfilade is reduced to the lowest expression, especially if the rear of the guns be secured by parados, or by ramps perpendicular to the rampart, as on the Gomer-Elson lines. But if a gun-boat be placed permanently upon, or occupy at intervals, a point in enfilade of a heavy shore battery, the conditions of the contest become most unequal. The gun-boat, with its power of movement, small bulk, and heavy armament, selects a position whence it can by projection of shells to the rear of the work distract the attention and annoy the gunners of any battery not entirely casemated. For in the case where the gun-boats' line of fire traces a very obtuse angle to the face of the work, the Haxo casemate would in itself be but slight protection against the scourging and searching fire from shell guns plunging in reverse. A floating shore-battery might take up the defence doubtless, but would in turn be shelled by another gun-boat, and a series of duels would result of giant against dwarf, where the chances were in favour of the party whose defeat or annihilation would probably be no equivalent for the loss previously sustained by the battery. Let it be supposed that a line of gun-boats is echeloned in shoal water in a line parallel to the faces of Fort Monckton, the Gillkicker Battery, and Blockhouse Fort. A more formidable line of battle in aid of an attempt to force the in-shore channel can scarcely be devised. And let the same conditions be applied in diversion on the eastern passage, from Fort Cumberland to the entrance of the in-shore channel. It may be assumed that this fire of support would be sufficiently destructive. It must be dealt with and dissipated on tactical principles, identical with those which define its adoption. The ascendancy acquired to the maritime attack by dissemination of fire over land defence must be reversed, and the superiority restored to batteries over the formidable gun-boat. But provision has not yet been made in the sea defences of Portsmouth to meet this contingency. It has been laid down by high authority, that under circumstances similar to those under which the attack of Portsmouth Harbour would be conducted, a supplemental fire on heavy vessels should be disseminated, because, in proportion to the dissemination of fire, loss is occasioned to the antagonist, whose fire is massed.

A very remarkable action might be quoted, which was fought in the Scheldt in 1814, with one 5½-inch howitzer and a field gun against the battery of a French frigate. The howitzer and field gun were placed in position on the banks, and the French frigate, lying in the channel, was ultimately obliged to weigh. This illustrates the advantage of a disseminated fire. It becomes a question, then, how far the direct fire of the heavy forts shall be supplemented by scattered batteries specially designed to act against gun-boats.

It may be well imagined that in the triangle, including the Spitsand, and in shoal water of $1\frac{1}{2}$ fathoms, it would be perfectly easy for a detachment of gun-boats so to take up their position that they would harass, and possibly even keep down, the fire of heavy guns mounted in works of rectilinear trace, while those very guns could not be brought to bear on the gun-boats. Now what is true of disseminated fire against batteries from the sea, is true of disseminated fire against gun-boats from the land. It is proposed then to construct a system of batteries as against gun-boat attack especially, but also to serve against heavy vessels. The conditions of construction of such lines are easily determined by the positions which lines of gun-boats would of necessity occupy for the purpose of co-operating in a maritime attack. Let a line be drawn from Southsea Castle at an obtuse angle to the salient of the King's Bastion, a distance line of 1,430 yards to the westward; and to the eastward draw a line passing through Lumps Fort at 1,600 yards, to Fort Cumberland, a further distance of 2,800 yards. Now it will not be sufficient to have a disposable force the specific duty of which shall be to engage a gunboat squadron, but it must also be so disposed as to overpower the gun-boat fire without accumulating such a mass of gunners and artillery within works under fire from the gun-boats, which would be murderous in its effects proportionately to the number of men and guns. Southsea Castle is supported on either point by two auxiliary batteries, having a flanking fire eastward and westward of two 68-pounder guns.

On these lines it is proposed to construct, at such a distance from the crest of the beach as should give sufficient command of the in-shore channel, and commencing on Southsea Common, a line of 3-gun batteries *en echélon;* these guns would be scarcely seen over the beach, while they would exercise a perturbing influence over the movements of the gun-boats. Three guns are assigned because the concentrated fire of three guns on a single gun-boat would probably occasion her to alter her position if stationary, or disorganise, if in motion, the system of delivering fire on recurring curves of approach and retreat. The fire of Southsea Castle might be advantageously delivered gun by gun. On the prolongation of the line towards Lumps Fort, and thence to Fort Cumberland, at suitable intervals, and at such an elevation as should give due command, batteries should be half sunken, constructed on the same principle, so that even if a line-of-battle ship worked into the channel, the probability is that but very slight harm would be done to the disseminated batteries.

It is with very considerable diffidence that I venture to make these suggestions, yet it has struck me forcibly, in the course of practice from the batteries of Southsea Castle, due regard being had to the peculiar nature of the entrance to the inner harbour, that it will be necessary to prepare some special system of defence against the class of attack by gun-boats, which would be very irritating, and might, possibly, become dangerous; and is, moreover, a system the materials of which lie within the capacity of non-maritime states, or maritime states of the second order, to organise at no great cost of money, men, or sea-going experience. A partial idea of the tactics applicable to an attack of this class may be easily obtained. The chart printed on the occasion of the Great Naval Review of 1856 represents the primary or original position of the men-

of-war, gun-boats, mortar-boats, and floating batteries, which were reviewed by Her Majesty at the termination of the Russian war. Those present will remember how triumphantly those magnificent 24 sail of the line swept the sea at Spithead without a sail being let fall. And they will also recollect the general effect of energy and concentration produced even by the blank firing in bombardment of Fort Monckton, from the mosquito fleet of gun-boats which anchored in shore. The positions pointed out in the chart give a very instructive lesson on the probable course of attack by heavy vessels, whether alone or assisted by mortar and gun-boats and floating batteries.

In considering the attack by direct fire, as on the Block House Fort, the question of construction of the embrasures of all works, especially of the casemated, becomes of importance. The engineers of the United Service have given much attention to this subject, with reference to their coast defences, and from the experiments recorded in the Report of Brev. Brig. Gen. Totten, on the effect of firing against embrasures, 1852, 1853, and 1855, it appears that by the employment of embrasures with offseted cheeks, as compared with embrasures with flaring cheeks, the conditions of entry of canister iron balls 1·05 are reversed. Thus—

Of canister iron balls . . . 1·05 diameter, per cent. fired
Against Embrasures with flaring cheeks 95 reflected, 5 stopped.
" " Offseted cheeks 6 reflected, 94 stopped.

The materials for construction in order of excellence are stated to be—wrought iron, lead, concrete, brickwork, sandstone, granite. But the tabulated results, p. 160 of the Report, are more remarkable as between ships and forts :—

TABULATED RESULTS.

Iron and leaden canister balls discharged in half an hour through embrasures of a casemated battery of twenty-four guns, and through port holes of a ship of fifty guns in each broadside, total surface fort and ship each = 6,000 square feet. In 32-pounders and 8-inch guns. Number entering each embrasure and port hole.

	No. entering each Embrasure.		No. entering all the Embrasures.		No. entering each Port.		No. entering all Ports.	
	Musket	Iron 1·05	Musket	Iron 1·05	M.	I.	M.	I.
From 32-pounders :—								
Large embrasure, 54ft. -	1,404	351	33,696	8,424				
Target embra. flaring cheeks	231	58	5,544	1,392				
——— offseted cheeks - -	101	25	2,424	600				
——— shutters - - -	10	3	240	72				
SHIP'S PORTHOLES	—	—	—	—	126	31	6,300	1,550
From 8-inch guns :—								
Large embrasure, 54ft. -	2,754	648	66,096	15,552				
Target embra. flaring cheeks	453	106	10,872	2,544				
——— offseted cheeks - -	198	46	4,752	1,104				
——— Shutters - - -	20	5	480	120				
SHIP'S PORTHOLES	—	—	—	—	252	52	12,600	2,600

The paper is to be found in Prof. Papers, R.E., which should be consulted on construction of offseted cheeks and of embrasure shutters.

With regard to the armament of the sea-faces of these batteries and of the works, the general employment of shell-guns should be insisted on; mortar fire is inefficient against shipping. The result of experiment from a 13-inch mortar at a range of 600 yards, against an anchored steamer whose beam shall be 40 feet, gives a per-centage of 16 hits. But there is another weapon, namely, the shell-gun, from which can be projected into the advancing vessel, a missile of sufficiently disruptive force, with much greater certainty of aim. And as to the result of the explosion of a shell on board a man-of-war, that remarkable instance of the explosion of a shell in the Medea, printed in Sir Howard Douglas's "Naval Gunnery," shows that the explosion of several shells must produce a most terrific effect on the strongest vessel. But it must be understood that the shell guns are to project shells, or red-hot shot, and not cold hollow shot, which is a projectile of the least satisfactory results of its class, fired from batteries against shipping.

Many interesting points of detail, as for instance the merits of the Armstrong and Whitworth guns, and of the resistance which plated vessels may be able to oppose to batteries, must necessarily be postponed. But it may be observed here, that the advantage derivable from the projectile will be multiplied and increased by successive trials, and it is probable that whatever resistance the strengthening of vessels may have given under the old system, will be still further increased by the powers of resistance given to plated vessels.

Still it is said that the Whitworth $8\frac{1}{2}$-pounder gun has pierced a wrought-iron plate of 4·5 inches at 200 yards. But the experiment was probably made against a stationary object (the floating battery), and on a line of fire perpendicular to the vertical plane of the target.

Is it to be assumed that the penetration would have been equal against an object in motion, whereof the point of percussion should lie in a plane inclined to the line of fire at an angle of not more than 15°? If not, then every gun commanding the channel of approach to a harbour must be capable of traversing at low horizontal angles, and in fact become a gun of *enfilade*, and, if not *en barbette*, the cheeks of the embrasure should be splayed proportionally.

But one disturbing element of calculation in the trace of sea works has already shown itself. The increased range of the Enfield rifle has extended the line of defence from 180 to 500 yards, as in the sea rampart and works at Alverstoke, that is as 3 to 1.

Passing from the attack to force the passage of the inner harbour, the consideration of Portsmouth as a maritime fortress is now to be approached. And here it becomes incumbent to refer to an omission which, no doubt, has already been noticed, namely, of notice of the defences of the Isle of Wight. Considering Portsmouth as a maritime fortress, the Isle of Wight must be taken as a work projected across the main ditch, or as an outpost to be most vigilantly guarded. I prefer assigning the tier-towers which have been suggested, and will be probably carried out on the Horse Sand and on No-Man's Land, to the defence of the passage of the eastward of the Isle of Wight, rather than to take them

into consideration of the defence of the harbour proper. The works then that are now available for the defence of the passage to the westward are, Victoria Fort, the Cliff-End Fort, and the batteries at Hurst Castle to the westward. On the south coast lie the batteries of Freshwater and the old work of Sandown, which though now valueless from decay, is well placed for sweeping the coast. I would here refer to the ingenious system of an anonymous writer who proposes for the defence of the coast line of England works which are thus described.

Vessels carrying batteries of heavy guns capable of injuring forts can nowhere approach within a considerable distance of the shore—this distance being generally greater where the nature of the coast affords, in other respects, fewer advantages for defence, and more facilities for invasion.

If the space near the shore within which ships and floating batteries cannot be brought, and which an invading army must cross in open boats, and if the beach and banks upon which it must land and form, be effectually under the fire of a sufficient number of guns, it will be impossible for a force, however numerous, to land its artillery and ammunition, except it can first silence the fire of these guns.

But because ships cannot approach close to the land, it is possible to plant guns protected from their fire that will accomplish the purpose.

Where the line of the coast has bold curves or projections, and the banks are elevated, such positions will, for the most part, be readily obtained, and require little aid from art to render them efficient for protection; but where such natural advantages are not to be found, earth mounds of adequate dimensions will do all that is required.

If small forts, protected either by the form of the coast, or by artificial earthworks, from fire from the sea (except that which is from too great a distance to injure them), made bomb proof and secure from escalade, be placed along the shore at proper intervals and positions, the fire from them will command every point on the shore, and the approach to it in such a manner as to render a hostile landing impracticable.

A bank of earth 150 yards long, placed along the beach close to high-water mark, sloping upon its sea face, and supported by a nearly vertical wall upon the land side, made of sufficient height and thickness, will protect guns placed near the centre of its length, pointed along the shore, from being fired upon from vessels, except from a very great distance. For instance, a gun placed 15 yards behind the embankment, is only exposed to a vessel that approaches within 400 yards of the shore at 2,100 yards distance; one placed 9 yards away from the mound does not become visible till a vessel as near the shore is 3,500 yards off; while one only 3 yards from the wall cannot be seen from a nearer point than 7,000 yards, and that only by a vessel within 250 yards of the land.

By making the bank sufficiently high, several tiers of guns may be placed in such a position, so that an adequate fire can be maintained in both directions along the beach. The shot from the guns three, nine, fifteen, yards respectively from the mound will strike the water's edge about 300, 500, and 1,100 yards from the guns.

It must be evident to every one at all aware of the effect of artillery, that such a raking fire *along the beach* as these guns could maintain would make it altogether an impossibility to land guns and ammunition either by day or night, in thick weather or in clear, by the most sudden surprise or the most extensive preparation; and that, to prevent artillery being brought on shore is all that is necessary to deprive invasion of any terror.

The cost of a bank of earth to protect a fort of three tiers mounting eighteen guns, need not exceed £2,000.

The cost of the fort itself, bomb-proof, surrounded by a ditch, protected by a gallery with loopholes for musketry in the wall of the earthwork, need not exceed £3,000.

The available range of rifled cannon, when used as these would be, may be assumed as extending at least to 9,000 yards (above five miles), so that a system of such forts placed at intervals along the beach, varying according to the nature of the coast line, of from two to seven miles, and flanked by similar forts, similarly protected, placed in the intervals between them, upon or near to the line of the cliff or bank, will effectually secure every point of the coast.

The cliff forts will protect the faces of the embankments in front of the beach forts and the parts of the shore not reached by their guns: also they will command the line of the cliff and the country inland to a considerable extent.

This system is not likely to require upon an average more than one fort for every two miles of coast, so that the cost need not exceed £2,500 per mile.

There is no form of coast line or kind of shore to which this species of defence is not adapted, the principle remaining the same, though the details would vary—it would be impossible to find any point upon the coast where a gun can be put on shore that may not be placed under the fire of a battery screened completely from being injured by fire from the sea.

This system appears to be specially applicable to works constructed in the bights of a bay, or on a projecting headland. A work to command Brading Harbour, and the anchorage of St. Helen's completes the land defence of the island to the eastward. And the sea-line will be closed by the two-tier towers hereafter to be placed on the firm ground of No-Man's Land and the Horse Sand. The question of forcing the passage of the Solent from the seaward has been often discussed, but chiefly with reference to the nature of the work at Cliff End, and its capabilities for a satisfactory defence. It was asserted that the heavy guns of this casemated fort could not be worked on account of the retention of smoke from the casemate construction, or that, if the guns could be continuously worked, the heavy firing would bring down the walls. When the Commission of National Defence inspected this fort, all the heavy guns were fired with 20 rounds each, and, while no wall of construction in the whole of that fort was shaken by that heavy firing, the guns were worked with the most perfect freedom from suffocation; and this is very remarkable, for the air was very still and the smoke almost motionless; the only difficulty was that the smoke, being, from the peculiar formation of the adjacent coast, completely shut in from the influence of wind from every quarter but to the direct front, hung before the works; a certain disadvantage, unless there was some current to sweep it away, but one equally affecting an open work. But even this disadvantage might be minimized by firing guns alternately, or at intervals, so that the smoke would lift by the concussion, and thus a constant fire be kept up upon passing vessels.

The batteries of Hurst Castle and its dependencies have been strengthened and enlarged, and under their slopes an experiment was tried very satisfactory to the position of troops lining a beach against disembarkation. It was doubted whether round shot in striking the beach would not produce, by displacement of pebbles, an effect analogous to that of shrapnel. Several round shot were fired from a gun-boat, against a target formed from sail. The shot struck at some 30 yards from the sail, and after a very careful examination not half a dozen pebbles were projected forwards to strike the sail. A portion of the crest of the beach had been swept bare by the round shot, but the shot deflected the pebbles upwards, and, consequently, riflemen might have been lying below the crest of the beach without any risk of being dislodged or wounded by pebble showers driven in upon them.

With regard to the defence of the Isle of Wight by troops, the opinion of a distinguished officer, Colonel Hall, of the Durham Artillery, is here by permission made public. "It appears to me that, supposing our fleet eluded or scattered after naval engagement, an enemy might land in Alum Bay with little difficulty; prepare a gun road to the high ground; seize Cliff-End earthwork, and taking in reverse Cliff-End and Victoria

Forts, command for a time the western approach to our great naval depôt at Portsmouth. From thence, proceeding north-east by Cowes, take Osborne, which would be occupied as a Quartier-Général. From Ryde, Spithead would be commanded, and even the dockyard at Portsmouth might be set on fire by rifled artillery. To meet such a force, *selon les règles*, 10,000 men would be required, of whom 600 should be trained field artillery men, with 490 militia or garrison artillery in the works of Fort Victoria, Cliff-End, Yarmouth Castle, Freshwater, and Sandown Redoubt. Two heavy batteries of movement, one nine-pounder battery, and a half troop of horse artillery, would give three field pieces per 1,000 bayonets nearly. Three hundred of the engineer corps would at least be required, considering the skilled labour necessary for the repair of the masonry, and iron racers of the armament. Deducting 200 for cavalry, leaves 8,400 infantry. The force to be encamped and entrenched would then amount to about 7,840." He then proceeds to suggest that a camp for 2,500 men should be formed between the village of Freshwater and Cliff End, leaving 5,250 to occupy the central and important position on the hill, which should be entrenched, to the eastward of Carisbrook Castle. "If, however, a battery of four 32-pounders (or heavier if completed) of the new rifled ordnance can be supplied and placed in position on a point a little to the north-west of the old lighthouse above Scratchell's Bay, the force above calculated might be reduced to at least one-third of the number. The soil here is good, unlike the unmanageable clay at Cliff End, and in this elevated position an earth battery, with embrasures protected from ships' musketry by mantelets, would suffice without multiplying the permanent works on the island. If such battery were well manned and officered, no vessel or boat even could pass, by day or night, through the narrow channel between the Needle rocks and shoal." These opinions show, first, what positive advantage and efficiency may be anticipated from rifled ordnance; and, secondly, how materially the great difficulty of getting a sufficient number of men for defensive operations would be obviated. This question, now so largely discussed and with such energy, is by no means new in the records of our country. A reference will be found in the "Sussex Archæologist," to councils held by Queen Elizabeth in the year 1589. To these councils were summoned her generals and statesmen, and their words and their warnings are applicable now. For instance, there is a general consent amongst those consulted that some fortification should be erected at Hurst; and over against Hurst, in the Ordnance map, will be seen marked "Cary's Sconce," "sconce" being then a term for "redoubt," and this, doubtless, was the *scondito* of the Italian engineers, and a work then projected under the auspices of that great soldier.

Lord Essex, advises, "that a great fort should be raised over against Hurst Castle." Lord Burghley suggests "that Portsmouth should have a sufficient garrison; and also that the Isle of Wight, with 900 men, could stay the possession of an enemy, as was proved in the last year of Henry VIII. when all the French navy was at St. Helen's, and their forces were repulsed by land by the forces of the Isle, with the aid of the two bands of Sir Francis Knollys and Sir Richard Bland. It is not probable," he says, "that Southampton would be attacked unless Portsmouth and the Isle of Wight should be attacked, but there he would suggest also

that some sconces or ravelins of earth should be made." Now this is the first time that ravelins are mentioned as a single or independent work. Much stress is laid on arms and training, and, with a true perception of the principles of defensive warfare, on breaking up of the country, and defence of positions. Sir Francis Knollys says:—"There must be men, and store of pioneers, but, if time permit, Plymouth, some place in the Isle of Wight, Southampton, Dover, Rye, and some places in the Thames, should be fortified." And thus speaks Carew, the Lieutenant of the Ordnance:—"The Isle of Wight is most needful to be respected. Portland, an island strong by nature, which by a help of a little would be made impregnable, if once gotten by the enemy, would give command and annoy us." Thus spoke the wisdom of our ancestors.

Passing to the consideration of the land defences of Portsmouth, I must ask those who have honoured us with their presence, to accompany me, as it were, to the crest of that long hill, so much spoken of lately, called Portsdown. Standing, then, on Portsdown, and looking southward, they will see close beneath the island of Portsea, containing the old town of Portsmouth, a parallelogram of about four miles by two and three-quarters or three miles. Looking to the westward, they will observe the long line of Southampton Water, and immediately on their right front the new line of works covering the suburb of Gosport. Southward will be seen on the sea margin the works which stud the entrance of the harbour, until at last the view is closed to the south-east by Fort Cumberland, protecting the entrance of Langston Harbour. Immediately below them they will see the Hilsea works, with six batteries and two redoubts, resting on the military canal, designed to prevent an advance on Portsmouth by an enemy disembarking on either flank. Fortunate it is, indeed, that attention has been directed so timeously to the essential works of defence.

Since these new works on the former line were commenced, the Hilsea lines have been projected, commenced, but are not yet completed, nor will they be during the course of this year. Within a very brief period projectile science has been so largely developed that, notwithstanding the outlay which has been made on those lines, it will be necessary to support them by additional works. There is no doubt that, to complete the defensive works, Portsdown Hill must be occupied. On the map is traced a zone of fire, taking the Dockyard as the centre, which is maintainable by the new system of projectiles; and, indeed, since that trace was first drawn, with abundant scope, as it then appeared, 1,300 yards additional have been obtained. Taking the Dockyard as the centre of the zone of incendiary fire, 8,000 yards overpasses the whole of the works now erected for the protection of Portsmouth. A bolt was recently projected 9,300 yards. Now the point at which Ryde Pier springs from the shore is distant from the centre of the Dockyard 8,800 yards. It is, therefore, evident that means must be adopted to remove, or impede, or interfere with, the power of the enemy to approach to such distance as may enable him to harass and annoy the garrison at long range, or, as in the case of the Dockyard, to destroy it by incendiary fire.

The works on the Gosport side, forming the Gomer-Elson lines, are well worthy attention. Their trace is very remarkable. Four have been

added to the original Fort Gomer to the northward; Forts Grange, Rowner, Brockhurst, and Elson. The position of these forts is marked on the map; and the three central forts have added to them a rear keep, in order to the maintenance of a substantive defence. They are worked out on that trace, that, in the event of one work being taken, it will not give an enfilade to the lines of the others. They are thus each capable of substantive defence, and if any one work were captured it would not lend facility for the capture of its neighbour, right or left. And it is evident that the ground in their rear may be swept by the fire of *rasé* hulks placed in battery in the upper part of the Harbour. Peewit Island might be occupied as a battery. But the independent character of these works is not their sole merit. A very large extent of adjacent land, amounting to 1,600 acres, is in the possession of Government, and will be eventually converted into one large parade ground. Thus will be attached to one of the greatest British arsenals, the finest parade ground in Europe in peace, and if the enemy should land and attempt to take Portsmouth from this direction, a magnificent plain studded with armed *points d'appui* and offering intervals of manœuvre to the troops.

I cannot here fail to remark a particularly beautiful application of engineering science. On the Gomer-Elson lines the ground is diluvial and of a very crumbling nature. The works are all excavated from the level, whence the *terreplein* of the work remains as an isolated block supported solely by the scarp. At Fort Elson the work appeared to be complete, when in one night the scarp was projected in mass ten feet into the ditch. It was therefore clear that the fault was not in the construction, but in the inability of mere brickwork laid at such a slope as to forbid escalade to resist the outward pressure of the shifting earth in the rear of the scarp. How was it then possible to resist the continual and unabated pressure, since the ground having once began to slip continued its outward motion? In rear of the reconstructed scarp, arches were turned like the dry arches of a railway viaduct, so that the whole of the scarp rested against their ends, the parapet above being sustained by the arch itself. As the earth from the interior gradually subsided into these arches it could be carried away, and thus an operation which might have been a source of continual expense, was limited to the labour necessary to relieve these works by hand. A very scientific application of the construction appropriately called the *escarpe en décharge.*

The inland lines of Gosport, Portsea, and Portsmouth, now lie far within the new defensive works. They are of a slight trace, and they would very materially depend on a water defence on the Portsmouth and Portsea lines. It is frequently supposed that an open suburb is on all occasions an inconvenience, or always leads to the disadvantage of the garrison. But the practice adopted by the Austrians may be remembered for instruction. Whenever it was desirable to strengthen a position in villages or small towns, the roofs and walls were removed to a certain height, then laying timbers horizontally on the walls, they were covered with earth, so as to make the buildings perfectly shell and fire proof. A suburb may be turned to advantage, and very materially delay the capture of a fortress. It is true that here the solid, powerfully con-

structed buildings necessary to make such a defence as that of Saragossa do not exist, especially in the suburbs of Portsmouth; but the defence might very materially be aided and protracted by turning to account the mass of buildings that mask the glacis of Portsea and Portsmouth.

And now it will be perceived how materially the command from the crest of Portsdown Hill, 450 feet, taken as a base of *emplacement* for artillery fire at long range, has changed the conditions of the internal defence of Portsmouth, as developed on the northern side of the island. It is not pushing a principle to extremity, to assume that the necessities of position urgently require the formation of a camp, or entrenched position, whereof Portsdown should form the centre or curtain, and Emsworth and Fareham determine the salients of the eastern and western bastions. The concentric lines of defence will then be clustered around Portsmouth proper, thus: Inner line—Portsmouth and Portsea lines, with the dependencies of Southsea Castle, two batteries, and Lumps Fort; on the westward, Gosport lines and Block House Fort. The outer line of defence to the eastward rests on Fort Cumberland by the sea; on the Hilsea lines to the northward; and is taken up on the westward by the Gomer-Elson lines, continued along the Alverstoke lines from the Browndown Batteries, through Gillkicker Battery, to Fort Monckton. The northern front is covered by the entrenched camp. From the crest of Portsdown there is an ample space for a powerful mass of fire. From the lines of Hilsea can be also concentrated a most powerful fire from six batteries inclosed in a solid rampart, and from two redoubts of the Ravelin trace, against an enemy, advancing from either direction, in order to turn the hill. The fire of these works is projected on parallel lines of fire, set at a large angle to each other, and thus securing a practical convergence of the first order; the prolongations of the respective portions of each work are directed on the least available portions of the country; and it becomes almost impracticable to enfilade by round shot, or seriously to annoy by shell the defences on the convexity or concavity of the *polygone renversé*, on which these works are traced. But, since military expeditions are now prepared for the accomplishment of an object by the combination of a multitude of small co-operating causes, as well as by the employment of a proportion of large means, it would probably enter into the scheme of an enemy, and would certainly be within his power, to place himself in the actual condition of works existing or projected solidly on Hayling Island, and use that position as a base of operations whence to annoy Portsmouth, or as a focus of artillery fire for its destruction. Is it not, therefore, desirable to construct works embracing within their combined curves of fire a very considerable portion of this island? It is proposed to construct two forts, not of the Maximilian trace, because it has been proved how thoroughly their armaments have been dismounted by field fire; but such works as, while enjoying a sufficient command of the country, should not expose a full front to fire in accomplishing the great object in war, the removal of the breaching power of artillery to the maximum distance.

It is probable that there are few spaces of ground of the same capacity and accidents as Portsdown Hill, in which there is so much dead ground. That will be the great difficulty to overcome in occupying Portsdown,

which being unoccupied, the gates of Portsmouth are left open, and its works uncovered to the first expeditionary corps disembarked on the coast. With regard to the construction of any proposed work, the advantages of material are great. The chalk is of great tenacity, and will stand with but little revetting.

The long ridge of Portsdown Hill measures, from the Nelson Pillar, west, to Belmont Castle, east, about 5 miles 2 furlongs.

The breadth of crest varies from 60 to 200 yards.

The crest line undulates with seven principal points of emergence.

The southern slope is steep, and indented into five principal hollows: the northern ascent is gentle.

The crest of the hill is about 7,040 yards from the centre of the dockyard, in an air line, which is therefore within the zone of incendiary fire from batteries on the western summits.

Works constructed on either extremity of the long axis of the hill would dominate the contained space of a circle inclosing Havant, part of Hayling Island and Bridge, Portsea, Fort Elson, and Fareham.

The possession of this height must then give a great preponderance, as affecting objective points of combustion, and it should be so occupied as to be capable of a substantive defence; and this effectual occupation may be effected by the minimum of labour, as the line of attack can always be exactly foreseen, and reduced to an alternative certainty.

But a peculiar geological formation of this hill enforces such a distribution of the works, that no dead ground should be permitted either on the crest or slopes. It is therefore proposed to excavate seven forts, of which the superior slope of the parapet shall be below the natural crest line at the seven dominant points; and to determine five batteries on the southern slope to search the hollows of that face with fire from their flanks, as well as to disturb any expeditionary movements of an enemy on the plain below, and to assist in defence of the slope from direct assault from the railway level. The northern slope receives its subsidiary defence from the covert way, running, as will be shown, below the crest on that face.

Now, it is essential that the inner crest works should have a double command, to north and south; and the outer crest works an additional command, as has been said, on the prolongation of the longer axis of the hill.

The fire must not be too plunging, and the batteries should be so placed as to have little to dread either from enfilade or vertical fire.

The ground lends itself singularly to these postulates, wherefore it is proposed to excavate works on an oblong trace, to consist, in one portion, of battery and magazine, in the other, of barracks.

The battery to be mounted on the outward faces, and to be entered only through the barracks.

The whole to be excavated from the solid chalk, with brick linings where occasionally required, as at the angles of galleries.

The work to consist of ditch and rampart; and within the excavation will remain the solid block to be hollowed into magazine and barracks.

Mortar platforms might be placed on the roof of the magazine and barracks.

The communications would be maintained by a sunken road, or covert way, with tramway for transport of heavy stores carried below the northern side of the crest of the hill.

Approximate length of works, 440 yards.
„ breadth of work, 220 „

The advanced batteries to be cut back into the hill, and protected from rolling shot or shell by roofs sloping from the upper ground, as in the road and galleries of the Alps. Their communications with the upper works to be maintained by winding roads, sunken, as may be seen in the existing cart tracks, on the face of the hill.

The upper edge of the natural glacis on the southern slope coincides with the limit of cultivation. It is proposed to draw a sunken road along this line, having a parapet to be maintained by the musketry fire of volunteers, and with heavy carronades projected in small caponieres from point to point, to check with their fire the advance of troops up the slope.

The excavated chalk will assist in forming firm ground for docks and quays, as shown in the plan.

The two Montalembert towers shown on the flat of Portsea are designed to complete the flanking defences of the island, and to serve against an enemy established, *en dépôt*, on Hayling Island. Farlington is stockaded, and inclosed within musketry lines.

Farcham furnishes an excellent polygon of defence; and a work capable of a substantive defence, at the junction of the Farcham and Titchfield and the Stubbington roads, would make Titchfield, with its inundations, a valuable bridge-head.

As regularity of fire from heavy ordnance is of more importance than rapidity for the defence of Portsdown Hill, the armament has been restricted to a small proportion of the heavier description, but the ramparts and parapets have been so arranged as to permit the transfer of ordnance to the side attacked.

And it is to be remembered that, as these works will be occupied only on special occasions, it would be necessary to detail no more than the actual number of officers, non-commissioned officers, and rank and file, required for the defence of the works, at the rate of two-thirds of the gun-detachments for the artillery service, and a proper proportion of infantry, without including in the establishment of the Portsdown system the mass of non-combatants required for the maintenance of works permanently garrisoned.

The general details of numbers for garrisoning the suggested works will appear in table; for it is essential that in the consideration of the defence of the district, an approximate estimate of numbers should be formed, the garrisons of the works completed or in progress being already decided on by superior authority.

But now comes the question of permanent fortifications. It is said that if a large outlay be made on defensive works, these works must be kept in serviceable condition by means of a large and expensive establishment, at a needless cost, when their service is not required; and that when occupied on a war footing, the garrisons are withdrawn from active service in

the field. With regard to the first remark, the problem is to proportion the minimum of defensive preparation to the normal numbers of troops on a peace establishment. With respect to the second, that objection was, I apprehend, very valid and reasonable in the old system of continental warfare. For if the projected works be considered as mere depôts of troops, as the fortresses of the Elbe, the Oder, and the Vistula in the campaigns of 1813 and 1814, by Napoleon during his reverses; if a garrison be allowed to remain passive spectators of manœuvres in the field, dynamic results are incommensurate with outlay. But if the due advantage be derived from their use as points of appui for a field force, which is the appropriate use of works like these on the Gomer-Elson lines, if they are so constructed as with a small garrison to make a substantive defence, while under their cover troops of manœuvre impede the march of an advancing enemy, then due tactical results will follow their adoption, and the national resources not have been diverted to a fruitless expenditure.

An important movement has recently arisen in this country, and one having especial significance in relation to defensive works. I refer to the organisation of Volunteers, who will doubtless verify the hopes of their country; and from this force may be drawn the materials for the special service of a strategy based on field movements appuied on fortified points, posts, and positions. In considering the functions of the national forces, it is not intended that the Militia, or Army of Reserve, should, except in the spirit of soldier-like emulation, become rivals of the regular Army, or that the auxiliary masses of the Volunteer Corps should be called on to perform other than appropriate duties. But, the Volunteers having shown an aptitude for the particular duties of defence, have satisfied many that, whereas it might have been formerly an injudicious policy to add to the extent of existing defence, that now the Volunteer movement justifies the construction of defensive works necessary to a complete system. And not only as regards the special employment of Volunteers for field movements of an irregular character, and the defence of posts by musketry fire, but also in serving the ordnance of field and other works by Volunteer gunners. In Great Britain there are now probably 150,000 Volunteers, of which 15,000, or 10 per cent. are Artillerymen. Time and training are needed to give that impassibility under fire which is the essential requisite of the Artillery soldier; but on the consideration of manning works, these 15,000 Artillerymen, exclusive of officers, will do their duty if they are properly trained to the specific service, and represent an aggregate of 1,500 guns. For in calculating the available strength of Militia and Volunteer Corps of Artillery, one-tenth of the entire body represents the number of gun detachments, there being no deductions for artificers or miscellaneous ordnance duties, as in the Royal Artillery, nor for sick or employed men; and, from the nature of the service, reliefs would not be required in the rigid proportions of a regular siege defence. For the service of the dockyards, it will be advisable to revive the dockyard battalions on emergency. It is doubtless true that the shipwright and anchorsmith should be shipwright and anchorsmith, and nothing else, in ordinary times. But great needs master economic axioms, and it is not improbable that the shipwright's task would be suspended per force when the guns of a breaching battery were opening on Fort Cumberland,

or gunboats sending their fiery hail athwart the harbour. Is then the proficiency required obtainable without sacrificing the hours of valuable labour? The recorded facts are these.

In 1847 the Dock Yard Volunteer Battalions were formed at the Seven Home Yards and the three Victualling Yards.

Commissions, signed by the Queen, were issued in 1849, to the several Officers, who were selected from the principal officers of the yards, the junior professional officers, and the clerical departments—the non-commissioned officers being selected from the inspectors and leading men of trades. Thus a body of useful intelligent men, who must have obtained their positions through their acknowledged ability in their several vocations, were placed over the artizans and labourers of whom the Battalions were composed.

The commissioned officers devoted their best energies to carry into effect the loyal intention which dictated the embodiment of these corps, and gave their attendance after the working hours of the yards gratuitously; they underwent the necessary drill under well selected paid serjeants of the Line and Marine Corps, and adjutants who were appointed from the Royal Marines and Marine Artillery. The zeal they evinced as well as the discretion they showed in handling bodies of men who, as skilled artizans, were likely to have objection to a position new to them, was most creditable.

The men surprised every person who witnessed their practice with field guns at targets moored afloat, as well as that made by the Boat Brigades, and with small arms, and they became qualified to prove a most useful auxiliary corps to the Professional Gunners for the defence of our Naval Ports and Arsenals. If it be urged that they might fail when under fire, the answer must be that there are no men more frequently subjected to serious cuts and blows, and that being Englishmen they would do their duty under any circumstances, and more particularly if called to defend their homes and country.

The drills took place within the Dock-yard Gates, and continued twice a week for two hours during the summer months, after the working hours of the yards. The effective strength of the whole of the Battalions, which were subsequently ordered to be drilled to the guns as Artillery Corps, may be taken as between 7,000 and 8,000 men and officers, and the amount of cost was about £9,000 per annum, which sum was taken in the Naval Estimates under Vote No. 8, "Wages," for the years 1850 to 1855, besides the cost of clothing.

In December, 1857, the several Battalions were reduced, the staff discharged, and the guns, arms, and stores returned. The officers were allowed to retain their equipments, and are anxiously expecting to be again embodied to join in the Loyal Volunteer Movement, which has been so strongly developed in all parts of the country.

This statement proceeds from an active F. O. of the Dockyard Battalions, and Lord John Russell stated in the House of Commons, Feb. 18, 1848, that the Dockyard Battalions, which numbered 9,800 gunners, had in charge 1,080 guns; being an excess over the previous calculation resulting from the smaller class of ordnance then in use.

Now these Dockyard Battalions of Portsmouth would release a force sufficient to man the works of Portsdown, or the detail given in the appendix, and a very large proportion of the new works.

In the year 1806 the garrison district furnished Artillery as follows:—

Portsmouth . .	225	Hayling . .	83		
Portsea . . .	225	Gosport . .	86	=	613

I now come to the consideration of Portsmouth as a base of operations against an invading force. I have had it strongly impressed on my mind for some years, that for political and social reasons, on which I will not at present dwell, whenever from political reasons it may be considered expedient to make an attack upon England, that attack will be made on a gigantic and unprecedented scale, in result of a formidable alliance, and by simultaneous movements on several points of Great Britain. If I am

not misinformed, the original plan of campaign in the Crimea was that of convergent attacks directed simultaneously on several points. It is believed that this plan was not approved of at the English headquarters, but was a scheme suggested as a French plan of campaign. Consequently it will be observed, in considering the fixed condition of the position of defence against invasion, first, that it is a felicity of our insular position that the various points of attack can as clearly be anticipated by the English Government, as predetermined by the invading powers. For, although the earliest point of attack cannot be precisely assumed, yet, knowing that it must be one of several, it becomes easy to provide against the contingency, by holding the means of defence in hand until the enemy has developed his plan of operations. In fact, the landing-places of England are *points obligés* either for attack or defence, and, in favour of the latter, a privilege vouchsafed to few nations. On the sketch map are laid down the general features of the shores of the country districts of the South Coast within which would probably lie the points of disembarkation by an invasion in force, either by expeditions in chief or by subsidiary corps.

An attack on Plymouth would probably envelope all the country below this range of hills lying between the Exe and the Tamar. And thus the provident sagacity of General Roy would be confirmed in marking out an entrenched camp to the west of the Tamar to cover Plymouth on that side, nearly 100 years since. If the enemy restricted his first onset to Portsmouth, the attack would probably be conducted by two simultaneous operations on either flank of the fortress, assuming the objective point to be to the westward of London and in the valley of the Thames. For an invader will naturally trust to overpowering or baffling the efforts of the British forces by his proficiency in strategy and manœuvres, and will therefore betake himself to the country which allows him ample room, and an opportunity of striking a blow effectively on the communications of London. That ground will be found in the valley of the Thames, probably near Reading. Then with regard to the northward, I have assumed that an expedition might be projected on the Cheshire Coast where troops might be disembarked in the estuary of the Dee; on the Lancashire coast, probably in Morecambe Bay, for the purpose of confusing and harassing our manufacturing population; on the north of the Tyne, to intercept any march of re-inforcements from Scotland; and also on south of the Humber. One of the most dangerous points of England for facilitating invasion appears to be the south of the Humber along the crest line of the Lincolnshire wold, whence it is practicable for an army to penetrate deep into the Midland Counties without much risk of being harassed on the march. Flank attacks by expeditionary corps up the Bristol Channel and on the East Anglian coast would envelop the country in one great net of threatened invasion.

Reverting then to the tactical and strategic considerations which determine the military importance of the district immediately dependent on Portsmouth, it will be seen that the country lying between the Avon, west, and the Adur, east, has special characteristics of high value. It offers, in fact, a mass of direct resistance to an enemy manœuvring on any line between Portland and Eastbourne, and the defensive front is generally as

one to three of the depth of the base line. It will now be surveyed in detail, observing its natural and artificial means of defence.

A point to the west of London being assumed as the objective point of an enemy (and it was on this supposition that the camp at Aldershot was formed), the Portsmouth district would contribute largely to the defences. For, though Portsmouth fortress might, perhaps, be masked, the district itself could not safely be neglected, and left on flank, or in rear, by a manœuvring force, since the troops occupying the district would operate on interior lines against an enemy advancing from either flank to their north-east or north-west on the capital, or on the objective point before suggested. If the advance of the enemy bore to the north-west from the neighbourhood of Brighton, in order to avoid the rough ground and gorges of the weald and the North Downs, then from the Portsmouth district a corps might be detached to hang on the flank of the advance until the troops were in junction with the Aldershot divisions. If the advance were from the New Forest to the north and north-east, the same manœuvre would be effective in reverse; if from both flanks at once, then the duty would be effectually performed by intercepting the enemy's communications between his divided columns. And in any case the country lying within the Portsmouth district might be left with a diminished force, yet so as to effect the means of rallying troops, retiring not in panic, but on strategic justification.

The Portsmouth district comprises the ground between the rivers Adur and Avon, on the east and west; the northern boundary stretches from Steyning along the downs, through Winchester to King's Sombourne and Bossington. The coast line from Red Bridge to New Shoreham defines the southern limit.

The country lying between the Adur and the Avon is distributed into five districts, marked by natural divisions, and closed on either flank, with one exception, by rivers, easily convertible into wide and deep inundations. The extreme flanks of this district are prolonged into the interior by canals; and one canal, traversing the Chichester district, forms therein a southern sub-district of defence.

To the north-east a long range of down country dominates the plain, with a rapid northern slope: to the northwest the high table lands on either hand of Winchester complete the border, within which lies a well-wooded and well-watered region.

The military organization of this district is detailed in the Appendix.

The defence of the district *A*, or New Shoreham, is not very important, though easy of arrangement.

Here, as in the other river districts, batteries of enfilade may be constructed to prevent the enemy from crossing the inundations. Guns might be obtained to any extent for this purpose; from the Arsenal, or even from the lines of Portsmouth.

The importance of the district *B*, or Chichester, is considerable, and is of a two-fold character; the light infantry defence of the down line to the north-east, and the standing defence of the line of river, and of the canal.

The Portsmouth district, *C*, is considered independently of the *enceinte* of the garrison, or of the resources furnished from the Royal Navy. It

enjoys the advantage of a triple railway service, but it is must not be forgotten that while railways assist in the concentration of troops which prepares success, the same concentration, becoming congestion, aggravates defeat, as was seen in the Italian campaign of the past year.

The Winchester district, *D*, on its north-eastern edge must be defended by the manœuvres of trained troops. and therefore steadily watched by the reserves of the central district, *C*.

The Southampton or *E* district has for its stragetic increment that effective resistance which can be offered by entrenched towns and posts covered and flanked by inundations.

Generally, the expedients for defence are endless. The inundations form barriers to an advance on Portsmouth from east or west. They are easily formed, and if barriers be constructed *en étage*, from level to level, not easily drawn off.

The Down line of stockaded village outposts might be strengthened by scarped roads, and other contrivances.

It would probably not be difficult to mount guns on naval slides for service on the railway lines.

The estuaries might be guarded by old hulks serving as gun-platforms and embedded in the mud beyond the reach of escalade or military boarding.

In the interior, where wood abounds, there are abundant means of forming a stockaded camp of refuge to receive non-combatants and stores.

Now with regard to Portsmouth, I have laid off the district thus :— The general defence would be divided into two portions, the defence of Portsmouth as a maritime fortress, and the defence of the district to which this fortress should be as the keep of an entrenched camp, and for an army of manœuvre a base of operations. For general purposes there should be established what may be called the Southern Army of the Coast, assuming Dover, Portsmouth, and Plymouth to be the three main objective points; and a force should be formed for their defence, distributed into three Army Corps, fifteen battalions of infantry for each Army Corps, two batteries of Royal Artillery, and a moveable battery of position composed of heavy guns, with a proportion of heavy cavalry; with the Volunteer Corps of the district, which should be attached specifically to each district until the determination of the enemy was made known. These corps should be massed on the great coast line of railway, with tents, camp equipage, stores, and baggage of every sort, so that the mass might be determined on any point. The railway accommodation and the railway power which would be required for such a force is easy of calculation. Thirty locomotives and proportionate numbers of trucks, waggons, and carriages would be required to move such a Army Corps, and to keep it available on the line of manœuvre, and thirty locomotives are the number allotted for the service of thirty miles of railway. The elements of calculation being given, power and distance, the result may easily be obtained. Sufficient importance is not attached to the strategic facilities afforded by our railway communication on lines of manœuvres or perpendiculars to lines of operation. Yet much remains to be done to perfect the means of military communication. The Great Northern Railway alone can carry chargers

on cattle trucks. Troops could be moved, concentrated, withdrawn, and dispersed with great ease on the railway lines. A system of railways in rear of Wilna would probably have saved a million of human lives, the conflagration of Moscow, and all the misery resulting from the inability of Russia to concentrate her retreating armies. The force required for the defence of the Portsmouth district is not, by means of rapid co-operation, necessarily very large. The entire periphery of the district to be defended, as shewn in the Appendix, is 150 miles. Therein are projected 13 fortified posts, 72 places of minor importance on the line of the Downs, and 18 small batteries to defend the passage of the rivers and inundations. Fifteen battalions of infantry forming the staple of resistance, of which five should be regulars, and ten drawn from the local militia of the neighbouring counties, would be sufficient to check, or at all events to harass, any force which might be landed, and the service could be performed without drawing on the permanent garrison of Portsmouth.

The Royal Artillery and the Militia Artillery will be disposable, as well as regular cavalry and yeomanry. Other local defences of posts might be in great measure entrusted to the Volunteers, when once properly trained to the duties of their special service.

It has been very justly remarked that the numbers required for the occupation and defence of works and districts are seldom detailed. Nor, indeed, is it possible to do so with perfect accuracy, although a reasonable approximation may be attainable; but the first necessity is to determine the nature of the defence to be made. In the Appendix will be found a topographical table of the Portsmouth district, (*A* and *B*); the number of volunteers in 1806, (*C*); the population of the same district 1851, (*D*); and the armament of the proposed works on Portsdown (*E*).

In considering the space to be traversed by the divisions of the Army of the Coast, it may not be inopportune to gauge the value of the system by the opinion of the most experienced tactician, General Dufour. Speaking of the establishment of fortresses of the 1st and 2nd class, he says, "Intervals of from 50 to 75 miles, in conformity to circumstances of ground, should be left between fortresses. Such is the distance which appears to consist with the great masses of modern armies, and with the present system of warfare. In rear of the first line of fortresses capable of sheltering a beaten army, should be traced a second at 75 or 100 miles. Then one last fortress in the heart of the country, the dèpot of the archives and arsenals, would offer a final asylum and anchor of security to its defenders. Excellent roads made in rear of the lines of defence would connect all these fortresses; they would give the troops power of movement with extreme ease from one to the other, without fear of a false manœuvre in face of an enemy, who, not enjoying the same advantages, is obliged to move on eccentric lines, to surmount a thousand obstacles in order to seize an easy communication to conduct him to his point of attack."—(Dufour, Fortif. Permanent, p. xiii.)

Now since space and time are for manœuvring synonymous, it will be seen that the railway system gives a great advantage in time, while the space required for free movement and choice of position remains unchanged.

TIME DISTANCE BY RAIL.

	Hours.	Min.
From Portsmouth to Plymouth . . .	13	25
„ Portsmouth to Dover . . .	5	7
„ Plymouth to Dover . . .	18	32

But as railways prepare for victory by rapid accumulation of troops, so defeat is aggravated by the constraint to retire on a single line, or by casual routes previously unexplored.

In the preceding suggestions it is not intended to sketch out a plan of campaign, but to point out the primary formation in which an attack might be awaited; and, considering that the advance of an invading force must be made from one of three bases, previously calculable, it would seem to be no very difficult matter to prepare alternative systems of defence, in any eventuality.

In providing the battalion mass of fifteen regiments, a suggestion may here be made—assuming that the three principal objective points of attack on the south coast, *not of disembarkation*, to be Dover, Portsmouth, and Plymouth, it would appear advisable to detail fifteen regiments (battalions) of the line, for coast service alone—to be echéloned on the coast railway, and to be designed to form a flying division for the special service of assisting in the defence by manœuvre of these named districts, with their proportion of guns and cavalry. Allowing five regiments of the Line and ten of Militia to each district, the distribution for Portsmouth would be as follows:—

	Combatants.
Five battalions of the Line at 800 effectives . .	4,000
Ten battalions of Militia Infantry at 800 ditto . .	8,000
	12,000

MILITIA BATTALIONS.

1 Hampshire,	in district	C.
1 Sussex	„	B.
1 Dorsetshire	„	E.
1 Berkshire	„	D.
1 Wiltshire	„	E.
2 Surrey	„	D.D.
3 Middlesex	„	A.B.D.

	Battalions. R.	M.
Or, District A. . .	1	1
„ B. . .	1	2
„ C. . .	0	1
„ D. . .	2	4
„ E. . .	1	2
	5	10

Considering the Tables C and D (Appendix), and the increased population, it may be fairly estimated that the Portsmouth district would furnish an increase on the levies of 1806.

Excluding then the garrison of Portsmouth, the final estimate might be taken to reach—

Fifteen battalions of Infantry . .	12,000	
Volunteers, Infantry	5,000	
		. 17,000
Royal Artillery (two field batteries) .	484	
„ „ (one of position) . .	242	
Militia Artillery	800	
Volunteer Artillery	500	
		. 2,026
Cavalry		. 500
Portsmouth District of all arms, excluding Royal Engineers		. 19,526
Dover and Plymouth Districts		. 39,052
Army Corps of the Coast		. 58,578

Let me in conclusion read to you the appropriate language of our forefathers of three hundred years ago. For I could not willingly let perish from the memories of Englishmen a speech made by Lord North at the Great Council:—"If the enemy is firmly planted, let him be blocked up with sconces, or fronted with a great army, giving him little rest." There spake the spirit of an Englishman under circumstances of heaviest discouragement. It mattered little to that gallant man that he saw arrayed against him men whose warfare had been tried by the stubborn Dutchmen, and by terrible struggles in the Crusading warfare of Southern Spain. It was sufficient for him that the enemy was there; he would have "blocked him up with sconces, or fronted him with a great army; giving him but little rest." (Appendix *F.*)

There is another point with which I shall conclude what I have had the honour of submitting to the meeting. Great attention was paid in those days to the arming of Sussex, and there was one officer, Sir James Colbrond, then deputy lieutenant of the county, who seems to have paid special attention to this. He says, on the last day of January, 1599, "The duty I owe to my Sovereign, and love to my country, hath caused me to write, as moveth thereto, the rather by reason of my observation of the country's unreadiness to march forward in August last, when as for defence of Her Highness' person royal they were hastily called for." He proposes "that the forces of the country should stand in continual readiness by previous organization, so that their duty of mustering should be with ease well or better performed in one day, if need be, more than in seven or eight days as it was aforetime upon the last great call for soldiers for Her Majesty's service of special importance." And he adds this: "All our hopes rest now upon our musquets and calivers, and good weapons they be if kept in readiness." (Applause.) And he concludes thus: "Now to conclude,

I am thence of opinion that the service will best get forward, and the charge and expense of time be least regarded among all them that serve and find arms, when the trained have justices of the peace and gentlemen of the better sort to be their leaders." Mark that; not one officer who bears the British commission, I am assured, thinks that either courage or good conduct, or the devotion that leads men to death, are the special inheritance of any class. We have had a striking instance and noble recognition of the fact that bravery and energy, truth and good conduct, are native in all ranks in the institution of the Victoria Cross. But it is in the constitution of ordered society that they, to whom Providence has assigned in this world less of its goods and more of its troubles than to their more fortunate brethren, should look of right to those on whom the heavy responsibilities of wealth have been laid, for that self-devotion, and above all things for that sober, loyal, honest guidance which the English people through all their ranks always recognise and appreciate with a proud obedience, unsupported by which they will not be content to serve.

Postscript.—The Report of the Royal Commission on National Defence having been published since the foregoing Lecture was delivered, the writer may be permitted to remark on the confirmation which the Report has given to his general suggestion that the defences of Portsmouth must be much extended. The proposed work on Horsea Island, named in the Appendix, would add largely to the strength of that flank of the defence. It may be doubtful whether the guns from the batteries on the Hilsea line can thoroughly search the dead ground on the southern slope of Portsdown, which contains hollows most favourable for lodgement and ascending sap, and the writer would therefore resort to the construction of batteries dependent on the upper works, as stated in the preceding pages. And, while so much thought has been taken to strengthen existing works by new constructions, the weak point lying between the Portsmouth and Portsea lines has not been overlooked.

There would appear to be much arrangement requisite that the tier-towers projected on the shallows of the Spithead anchorage may not mutually blind their fire against vessels of small draught and heavy armament.

The long-range projectile will be probably employed in these batteries, and it might be a matter of renewed inquiry whether gun-cotton might not be advantageously employed in the armament of works of this class, where clear sight of the mark is essential to the development of the powers of the rifled ordnance, especially since fire *en ricochet* cannot be depended upon as in smooth-bore cannon.

The writer cannot refrain from congratulating the country on the production of a Report of a character alike bold, comprehensive, and scientific.

APPENDIX.

A—Table of Districts.

	A.	B.	C.	D.	E.	
River	Adur.	Arun.	Titchfield.	Itchen.	Avon.	Total.
Chief Town	N. Shoreham.	Chichester.	Portsmouth.	Winchester.	Southampton.	
River line, length	4·4	8·4	14·4	12	12	51·4
Principal Stations	2 N. Shoreham, Bramber.	3 L. Hampton, Bury, Arundel.	2 Titchfield, Wickham.	3 Twyford, Bishopstoke, Bp. Waltham.	3 Bossington, Romsey, Tolten.	13
Outposts	5	7	3	2	12	29
Line of Downs, length	10·4	12·4	12	—	—	35
Principal Stations	3 Steyning, Stonington, Amberley.	3 Bignor, Cocking, W. Lavington.	5 S. Harting, Buriton, S. Meon, W. Meon, Warnford.	—	—	11
Outposts	3	8	4	—	—	15
Coast line, length	10·2½	10	Garrison.	8·4	3	31·6½
Principal Stations	1 Worthing.	1 Slindon,	Garrison.	1 Hamble.	1 Redbridge.	4
Outposts	5	5	Garrison.	1	—	11
Inland line, length	—	—	11	12	8	31
Principal Stations	—	—	2 Hambledon, Horndean.	5 Hinton, Ampna, Cheriton, Titchbourne, Kington.	1 King's Sombourn.	8
Outposts	—	—	4	6	1	11
Batteries on Rivers	2	5	—	5	6	18
Regiments of Infantry	2	3	1	6	3	15
Sub-district P. Posts	—	1	—	—	—	1
Interior Posts	—	6	—	—	—	6

Boundaries of Districts.

A district extends from N. Shoreham to Bramber; by downs to Amberley, thence to L. Hampton, and by coast to mouth of Adur.

B district extends from mouth of Arun to Arundel, thence to Bury by downs to Twyford, and by Beacon Hill to Emsworth, and by the coast to Arun river.

C district extends from Emsworth to Beacon Hill by Bow Hill, thence to W. Meon and mouth of Titchfield river, and by the coast to Emsworth.

D district extends from mouth of Titchfield river to Warnford, thence to Winchester, and by Itchen river to coast and to mouth of Titchfield river.

E district extends from mouth of Itchen to Winchester, thence by King's Sombourn to Bossington, down the course of the Avon to Redbridge, and by the coast to Southampton.

B—SUMMARY.

Entire length	149·2½
Principal Stations	37
Outposts	72
Batteries, Rivers	18
Regiments of Infantry	15

MEM.—The defence of the Rivers, on both banks, is assigned to the District lying inwards; Portsmouth therefore has two inner lines.

C—In 1806 the Portsmouth District furnished Volunteers as in List annexed:—

HANTS	Cavalry, 465	Artillery, 923	Infantry, 4,040
SUSSEX	„ 172		„ 1,637
	637		5,677

D—POPULATION OF PORTSMOUTH DISTRICTS—CENSUS 1851—MALES.

Havant	3,432
Portsea	35,920
Alverstoke	8,564
Fareham	6,874
Southampton	15,875
South Stoneham	7,605
Romsey	5,377
Winchester	13,146
Petersfield (half)	1,956
Droxford	5,493
Steyning	8,296
Worthing	8,862
Chichester	7,083
	128,484
Deduct Army and Navy	15,000
	113,484
One-fifth of the Population =	22,697

E—ARMAMENT OF PORTSDOWN WORKS.

WORKS.	ORDNANCE.			TOTAL No. OF GUNS.
	68-Pr.	8-In.	32-Pr.	
EACH.				
FORTS—A. M.	4	4	12	40
„ B. F. H. K.	2	2	10	56
„ E.	4	4	10	18
BATTERIES—C. D.	—	2	5	14
„ 9	2	2	6	10
„ 1, 4	—	2	5	14
	22	30	100 =	152

F—In June and July, 1588, the Royal Forces were thus distributed :—

	Men.
1. For the defence of Her Majesty's Person, drawn from the Mid-England Counties .	28,900

	Infantry.	Lances.	Light Horse.	Pioneers.
2. Field force drawn from the Southern Counties	27,000	407	1,901	4,892
3. To attend on the Lord Steward . .	22,000	203	669	

	Reserves.	Depot.
1. For the defence of Her Majesty's Person	17,600	11,009
2. To attend on the Lord Steward . .	6,000	11,536

	Of all Arms.
3. South Wales	24,664
4. North Wales	21,344

Friday, June 29th, 1860.

CAPTAIN E. G. FISHBOURNE, R.N. C.B. in the Chair.

SHOT-PROOF GUN-SHIELDS AS ADAPTED TO IRON-CASED SHIPS.

By Captain Cowper Phipps Coles, R.N.

My object in addressing this meeting is to explain briefly the successive steps by which I have arrived at certain views, having reference to vast changes which arms of great precision, more especially rifled cannon, are calculated to produce in future warfare.

My attention was first drawn to this important subject during our recent war with Russia.

Some whom I see present are acquainted with the history of the "Lady Nancy," a raft carrying a 32-pounder, which was used during the Russian war with great effect in the Sea of Azof. A model of her is before you; but I will not on this occasion enlarge upon her character. A description of her was published last year.

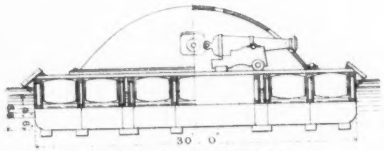
Finding that a single gun on a steady platform could do so much execution, I next turned my attention to the effective protection of the crew, gun, and magazine. This led to the design of another raft (fig. 1), which is provided with an hemispherical iron shield over a 96 cwt. gun. This raft is composed of numerous empty casks. When under fire, water may be admitted into the apartments containing the latter, so that, the structure being then floated chiefly by the buoyancy of the casks, a diminished area is exposed, and in the event of penetration by red hot shot or shell, ignition would be prevented. It will be seen by the drawing and model that a small portion only can be reached by horizontal fire, and this portion is sloped at an angle of 40 degrees, and faced with 4-inch iron. As to vertical fire, I believe there is little to be apprehended, from the uncertainty attending its effect on a moving object. If a 13-inch shell should strike such a raft it would do little damage beyond destroying one or two casks, the loss of whose buoyancy could well be spared, as the gross displacement of casks is almost one-third in excess of that required to float the vessel at a proper fighting height. It appeared that such structures would be very efficient in attacking the Russian forts under circumstances which would not permit the approach of our heavy draught as well as heavy armed ships.

GUN OR MORTAR CASK RAFT WITH SHOT PROOF SHIELD.

By Commander Cowper P. Coles R.N.

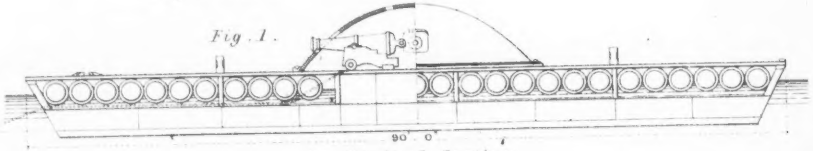
August 1855.

Fig. 1.



Transverse Section

Fig. 1.

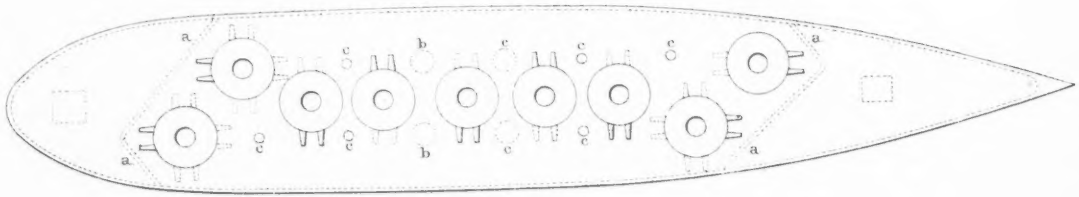


Longitudinal Section

PLAN OF DECK OF SHIELD SHIP.

Shewing the number of Guns that can be brought on either broadside, or right ahead and right astern.

Fig. 6.



a.a.a.a. *Extremes of Shot Proof portion of Ship.*
b.b. *Funnels*
c.c.c.c. *Ventilators*

J.R.Jobbins.

The draft with armament complete, one 68-pounder, is only 3 feet 7 inches before the admission of water, and she may be immersed 5 feet 3 inches without bringing the gun within 4 feet 6 inches of the water.

My proposition was that a number of these rafts should be prepared and taken out in portions to the Baltic for the purpose of attacking Cronstadt, one-third of them being fitted with steam power, so that the whole, without any extraneous aid, might proceed to action under steam, passing along the shallow wafers towards which the constructions and arrangements of the forts would not permit their fires to be directed. In the meantime our heavy ships could be engaged in the deeper water; and I think there can be little doubt that the easily converged fire would have had an immense advantage over the small amount of fire which could be brought to bear by the forts upon the rafts in shallow water.

In consequence of the favourable Report * of a Committee in November 1855, I was ordered home from the Black Sea, and had the honour of explaining to the Lords Commissioners of the Admiralty the nature of the proposed shot-proof raft and shield. At this juncture peace with Russia was proclaimed, and the Government did not therefore consider it necessary to proceed with these matters. Since then, while on half-pay, I have occupied myself in preparing numerous drawings and models, which resulted in these now before you.†

I will first describe fig. 2, which represents part of the side of an ordinary frigate as now built, iron-cased, to 8 feet below the water-line, two port-holes being represented, each having an area of 13 square feet entirely exposed to shot, shell, and musketry; immediately in rear of which space are grouped the guns, and the crews which fight them. The serious disadvantage resulting from this condition struck me particularly at Kinburn,

* H.M.S. Stromboli, Kasatch, in the Black Sea,
13th November, 1855.

Pursuant to an order from Rear-Admiral Sir E. Lyons, Kt. G.C.B., Commander-in-Chief, &c. &c. &c. we, whose names are hereunto subscribed, have repaired on board H.M.S. Stromboli to inspect a gun-raft proposed by Commander C. P. Coles, R.N., and we are of opinion that the invention is one of the greatest practical value.

It appears by the model which Commander Coles produced that the raft combines many advantages, amongst which are—

1st. Light draught of water.

2nd. Facility of propulsion.

3rd. Simplicity and rapidity of construction.

4th. Great buoyancy; one heavy gun or mortar can be used on each with great precision of fire.

5th. Protection of the crew.

Looking to the probable nature of future operations against our present enemy, we are further of opinion that this proposal merits the immediate attention of H.M. Government; and, in order that the full benefit may be derived from it, we venture to think it desirable that Commander Coles should be directed to proceed to England and personally to explain his proposal to their Lordships.

We further suggest that under present circumstances *secrecy* is desirable.

President.—Rear-Admiral Sir Houlston Stewart, K.C.B.
Captain Arthur Cumming, R.N.
Captain E. A. Inglefield, R.N.
Mr. Rumble, Chief Engineer of H.M.S. Royal Albert.
Carpenter of H.M.S. Hannibal.

Present,—Captain H. Hay, H.M.S. Hannibal.

† The models are to be seen at the Royal United Service Institution.

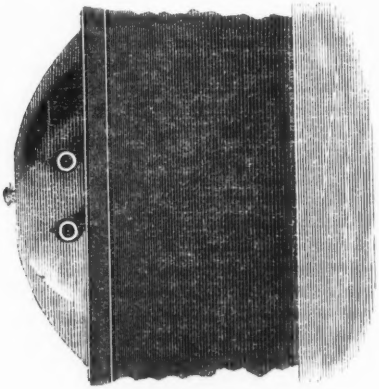


Fig. 3.—SHIELD.

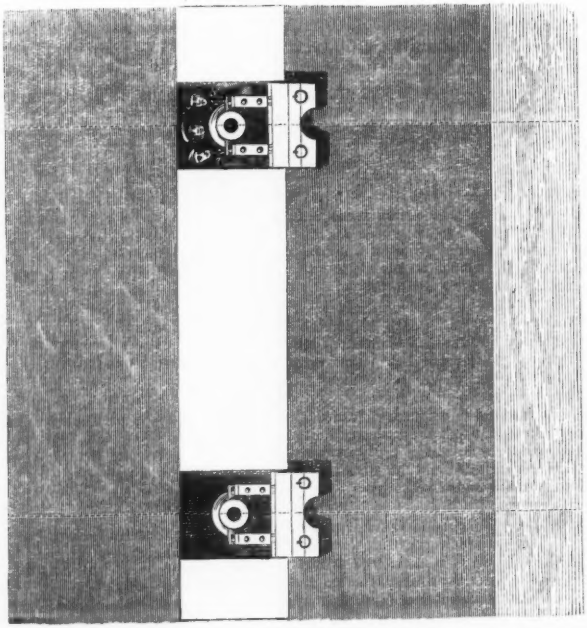


Fig. 2.—TWO PORTS.

when the French floating batteries experienced several casualties effected by shot entering the ports while under a very feeble fire at the distance of 800 yards. It appeared evident that, with the great precision of fire now attained, even iron-cased ships must thus suffer great loss when engaged in close action under a vigorous fire, particularly from grape and cannister, and that even one shell of molten iron or liquid fire might on entering a port entirely destroy the vessel, or produce a fatal confusion.

Further consideration strengthened my conviction that the coating of a ship with iron plates, and leaving a perfectly exposed area, amounting in the case of a vessel of 20 broadside guns to 240 square feet, would be abortive.

I beg now to draw your attention to the drawing (fig. 3), in which are represented 2 guns, placed under either a hemispherical or a cone-formed shield. The port-hole is entirely closed by the gun, save the small space sufficient to permit an elevation of 10 and depression of 7 degrees. The horizontal motion or "training" is effected by turning the shield itself, with the gun, crew, and the platform on which they stand. The whole apparatus thus becomes as it were the gun-carriage, and, being placed on a common turntable, can be revolved to the greatest nicety of adjustment by means of a winch, or of handspikes at the circumference, or of levers in the pivot.

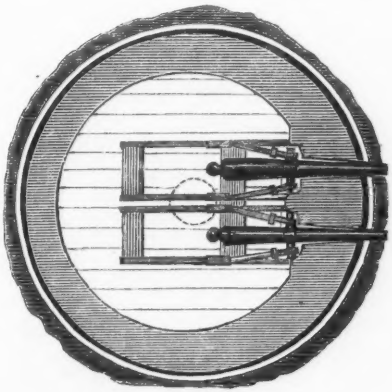


FIG. 4.

Fig. 4 is a plan of the shield, showing the 2 guns and carriages placed parallel, and as close together as the trunnions will allow, but working quite independently of each other. The pivot (see fig. 5, *a a*) is a hollow cylinder 3 feet in diameter, through which the powder is handed up from the magazine, and communication obtained. A current of air is kept up through this hollow pivot by means of a fan, which causes the smoke directly it leaves the breech of the gun to escape through the corresponding opening immediately above it; and should this not be sufficient, a blow-pipe supplied by the fan can be entered into the breach of the gun before the plug is drawn, which on being raised the current of air would force all the smoke in the bore outboard. In a shield constructed according to my invention, the interior *b b* is a wooden dome, composed of massive

vertical parts mutually supporting each other, and tied together by means of bolts and a hoop.

The whole exposed upper portion, *c c*, above the glacis is covered with 4½-inch plates, and theother part is sunk into the deck, and protected by an iron glacis.

Aim may be taken either through a "sight" fixed on the top of the shield, or on the gun, or two may be found advantageous, that on the shield performing the same office as the small "finders" of a large telescope, the shield being as it were the carriage of the gun, and the two always retaining the same relative position.

Although there is a height of 7 feet inside, there are only 3 feet 8 inches exposed above the glacis, consequently there is only a small exposed area. From its globular form no horizontal shot can strike it except very obliquely, when the shot would glance.

No shot has yet penetrated a 4½-inch plate at any considerable angle. Fig. 3 represents the apparatus placed amidships in a flush deck vessel; and fig. 2 two broadside guns of the same calibre out at the perpendicular sides of an ordinary built ship. It is evident that the first shot of a rifled gun might enter the port of the latter, destroy several men, and disable the gun by direct injury to it or the carriage, whereas the shield gun presents nothing but its muzzle. Moreover, the latter trains through the entire circle, the ordinary mounted gun only through an arc of 45° each way.

Fig. 5 shows an entire vertical section of a ship of the same general dimensions and draft of water as the large iron frigates now being built; one side, *d d d' d'*, represents 4½-inch iron plates over 18 inches of timber backing, supported by an iron framing and an inner skin; *e e* would be the main deck of an ordinary frigate; *f f* the lower deck. The main deck is occupied by the turntables for the shields placed amidships of the deck, supported by numerous iron stanchions between decks from top to bottom. The communication with the lower and weather deck is by means of a 3-foot hatchway to each shield in the shape of a hollow cylinder or pivot, *a a*.

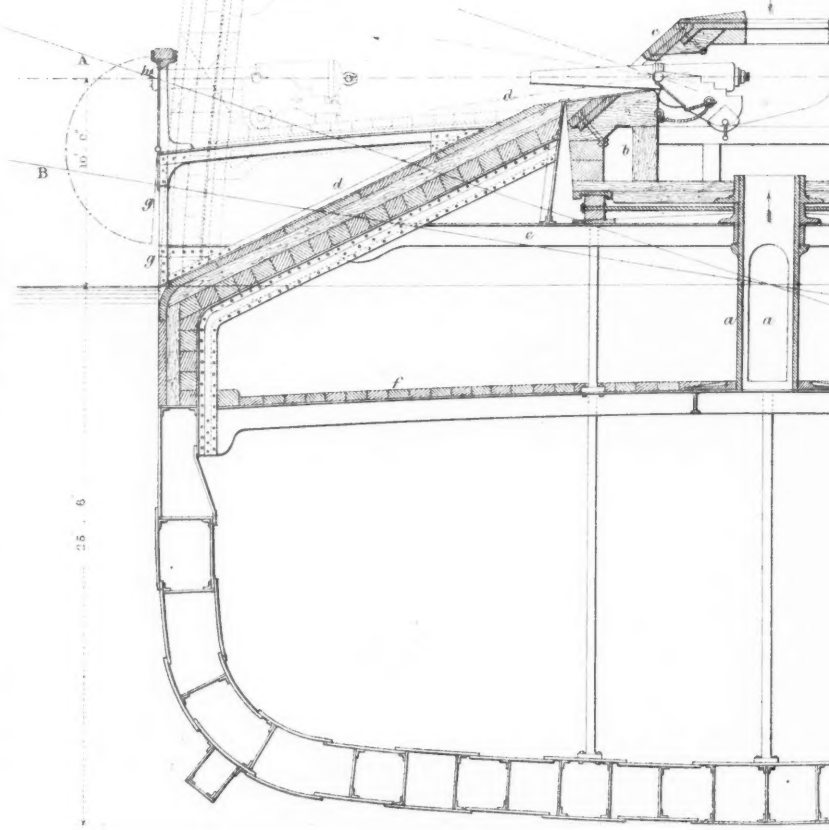
Now, it will be seen that no horizontal fire can strike this structure above the water line, except at an angle of 40 degrees, and that it is completely protected against vertical fire by its arched roof; it is supported on each side at three or more points by stanchions, or fore-and-aft bulkheads if necessary.

An enormously strong ship is thus obtained—not weakened, as are ordinary ships, by numerous portholes, but having a continuous side, with the weights placed amidships instead of at the sides.

The experience furnished by the late gales of the effects upon the heavy wooden ships of our fleet, when after a few days' bad weather they were all more or less damaged and unfit for any continuous service, leads me to the conclusion that the enormous iron-coated ships now building, of great beam, with immense weight of iron on their perpendicular sides, will strain themselves exceedingly, and require constant expensive repair, or soon be rendered altogether unseaworthy. Water getting between the iron plates, parts to which the sun can never penetrate, will always be in a state of moisture. This I believe to be one of the causes of the "Trusty" being rotten.

~~Fig. 5.~~

TRANSVERSE SECTION OF A SHIELD SHIP ON CA
And also of an Ordinary Ir
The Upper sides and the Decks of the latter are sh
Water being common



A. *Water line, when Ship heels 49° shewing that then the Muzzle of Gun in Shield Ship is 5.*
B. *Dº 40° Dº 8.*
i. Ventilators for lower Deck.

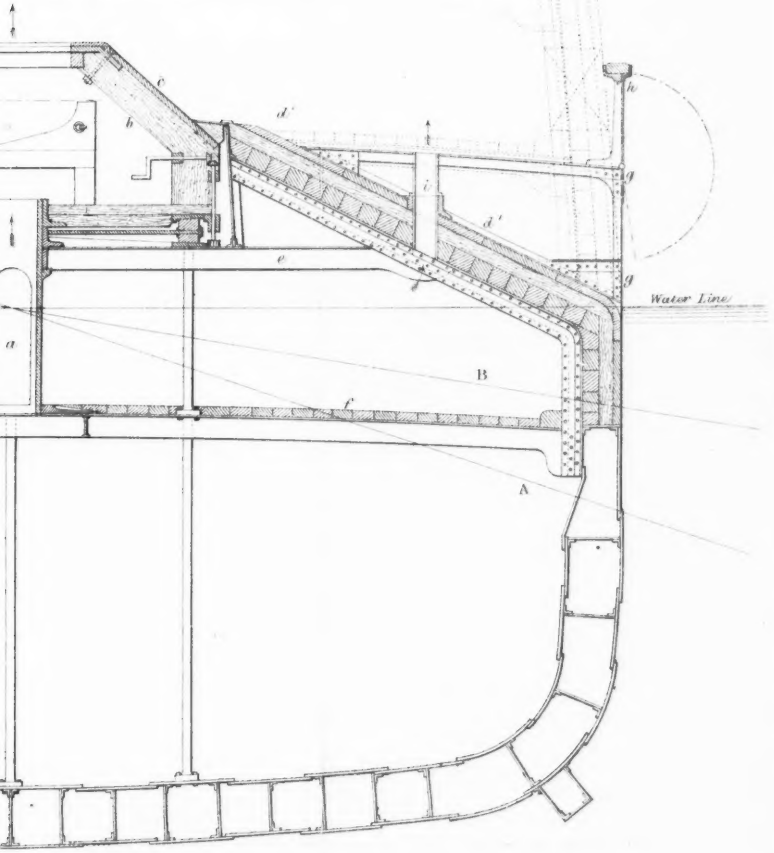
V c unit reverse 3½ wider wide

8. 5.

P ON CAPTn COWPER P. COLES' R. N. PRINCIPLE

dinary Iron Cased Ship

tter are shewn by dotted Lines: the part below
common to both.



hip is 5'. 9" above Water and that of Broadside Gun in Ordinary Ship is in the Water
8'. 0" D° is 5'. 0" out of the Water

J.R.Jobbins

As a ship of this form with inclined sides, *d d d' d'*, would have no stability, she would be a bad sea boat, and be washed over by a sea, owing to the absence of sufficient extra displacement.

A second or outer side, *g g g g*, is therefore provided with numerous compartments of iron plates as lightly constructed as consistent with the strength requisite to resist a heavy sea. It is fitted with a falling iron gunwale, *h h*, to allow the gun to be fired over all. A good deck on either side of 18 feet breadth is also thus afforded.

The compartments should be kept perfectly empty, excepting a space required for the stowage of boats. The accommodation below is the same as that of an ordinary frigate. There is ample provision for ventilation in a hatchway of 3 feet diameter, and a corresponding open space at the top of each. There is also room for a hatchway on both sides between the shields. The main deck being secure from water may consist entirely of grating work, or be quite open between the beams, so that the height of two decks is thrown into one for air and light. Durability and prevention from decay is another important feature in these ships. Water cannot get into the inner portion of the structure without first passing through the outer coating. Those who are aware of the destructive effects which are sometimes caused by the penetration of water to the unventilated parts of a wooden fabric, will appreciate this feature.

With reference to steadiness in a seaway, it is clear that from the iron-cased portion inclining inwards, as well as the position of the heavy guns and shields amidships is more favourable than that of the armament placed in the ordinary way through heavy vertical sides; and it is unnecessary to enlarge upon the extreme *desirableness of steadiness of gun platform in a vessel of war*. The very act of working guns on the broadsides causes our present ships *to roll several degrees;* but here, the gun and appurtenances being in the centre, the movements would be comparatively insignificant. Moreover, when the muzzle of a gun at the side would be under water, that of a gun placed amidships would be perfectly clear of it, and with a given roll of ship the former would pass far more rapidly through a greater distance than the latter in describing a similar arc.

In shields the captains of the gun being able to see the masts of the opponent above the smoke would always keep the object covered, so that the gun would be fired as soon as loaded, without any further training: much would thus be gained in rapidity and precision of fire. The shield would contain two guns each; and I so place the foremost and aftermost shields, that four guns can be brought right ahead or right astern without transporting from broadside to bow ports (see fig. 6), as required by the ordinary port system. Indeed ordinary iron-cased ships cannot have bow or stern ports without incurring the risk of being raked, and of their battery being disabled through the ports. A raking broadside could do little or no harm to a shield-ship such as proposed. She has the power of concentrating her broadside with great precision, the degrees being marked on the circle. From each shield two 100-pounder shot can be thrown simultaneously within 3 feet of each other, by merely connecting the two trigger lines; and, if boarding were attempted, they could sweep the upper deck with grape and canister, each gun clearing its own portion of the deck; and 8

guns, four aft and four forward, might rake the deck right fore and aft at the same time. Indeed it may be safely affirmed, that no enemy could for a moment stand upon the deck, whilst the crew of the vessel would be perfectly secure within their iron shield.

In future warfare, when iron ships become general, in conjunction with the power under steam of closing at pleasure, a determined enemy may prefer the issue of a hand-to-hand combat to the fruitless waste of projectiles on an almost invulnerable hull. For such a contingency it is well to be prepared, and, judging by the results of bygone days, we have no ground for discouragement, should boarding, as in old Roman and Grecian times, be again the ordinary way of meeting an enemy.

I will now point out the comparative destructive powers obtained through the shield and the ordinary port system. The two drawings (figs. 2 and 3) show the comparative lengths of longitudinal space required for 2 broadside guns on the two principles. Two broadside guns on the old plan, with 3 feet 6 inch ports 12 feet apart, occupy 31 feet. Two guns under the shield occupy longitudinally 20 feet; thus one-third in space is gained by the shield, and it will easily be seen that one-third less length of ship is required to be fortified when mounting the same number of broadside guns. Although these guns are of the same height from the water, this ship has much less area exposed, being much lower and of less length than the one with port-holes. This is a decided gain to the shield-ship in weight, expense, and the chances of being hit.

I must beg you to bear in mind, that in all my calculations I compare broadside with broadside, and not the number of guns that a ship carries: for example, we hear of 120-gun ships, but it must be remembered, that they can only bring 60 guns to bear on one broadside. The shield-ship brings the whole of her guns to bear on either broadside, and 4 guns right ahead or right astern.

I will take first for example a ship with perpendicular sides coated with iron (see fig. 7), according to the present system, with the general dimensions of the "Warrior," which is 380 feet long, and, although she has a broadside of 18 guns, only 13 of these are protected by 4½-inch iron, requiring 213 feet of longitudinal iron-plating. A ship of the same general dimensions on the shield plan would have 20 broadside guns thoroughly protected, as before described, by 4½-inch iron. In my comparisons I will consider those guns alone to be protected, as it is hardly necessary to point out that a three-decker's broadside would soon put *hors de combat* those unprotected, then the destructive power of the shield-ship would be to the other as 20 is to 13.

But suppose a shield-ship built with a broadside of 18 guns all protected by 4½-inch iron, she would only require a length of 180 feet to be plated with iron, whilst the "Warrior," for the protection of only 13 guns, requires a length of 213 feet. Figs. 7 and 8 show the relative broadside areas of the two ships, from which it will be seen that the shield-ship, requiring so much less space for her guns, may be much shorter, and, therefore, not only less costly, but by far the handier of the two.

With regard to strength and power of resistance it would be difficult to draw a comparison, the side sloping at an angle of 40 degrees having so great a superiority over the perpendicular; but we may form a near

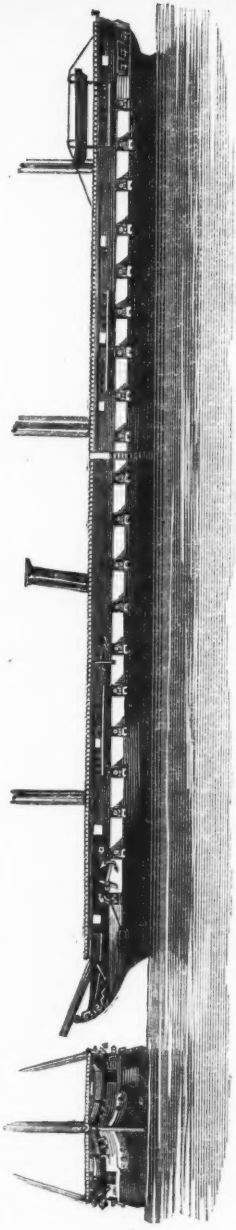


FIG. 7.

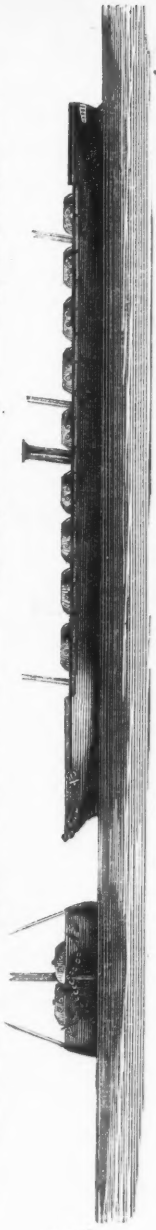


FIG. 8.

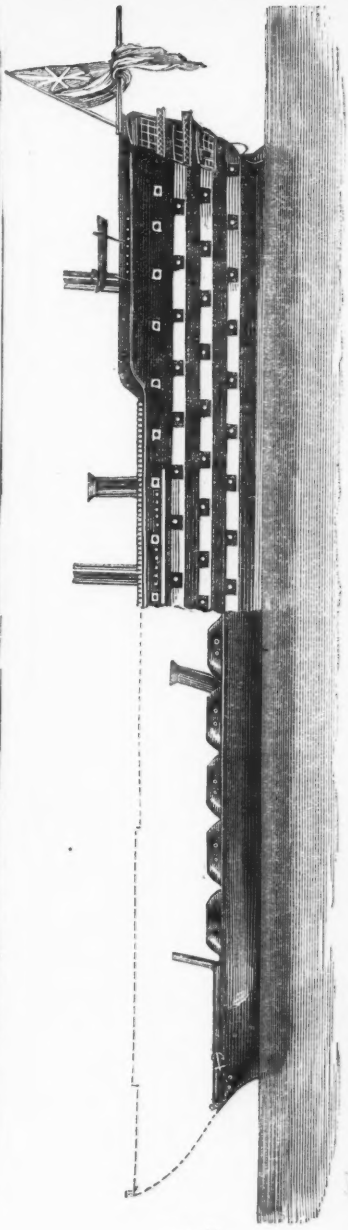


FIG. 9.

enough estimate with reference to the entirely unprotected portion of the respective ships.

The ship (fig. 7) with 18 ports, 3 feet 10 inches by 3 feet 6 inches, has a space of 241 square feet open to horizontal fire, and an enormous upper deck unprotected against vertical fire. The shield-ship has no opening large enough for a 32-pound shot to enter horizontally, or through which riflemen can do any execution. Against vertical fire they are entirely protected, except the small hole in the centre of each shield, and the chances are very much against this being hit. Should a shell strike this sloping structure, I imagine it would glance off, or, at all events, do less damage than plumping down on a flat deck.

I will now compare its powers of resistance and destruction with those of a wooden 3-decker. Fig. 9 shows the half broadside of a shield-ship and of a 3-decker, the hulls being of equal length. The shield-ship has a broadside of 20 guns, 100-pounders, the 3-decker a broadside of 60 guns of various calibres. I will first call attention to the comparative areas to be aimed at, and the chances of being hit. The 3-decker presents an inflammable area, vulnerable to shot, of 10,150 square feet; the shield-ship, 3,750 square feet, both invulnerable to shot and uninflammable.

It must be remembered that after the first two or three broadsides the ships become enveloped in smoke, little or nothing is seen beyond an occasional glimpse of a mast peering through the smoke, giving the low object then a great advantage over the high one. We know, also, that as the guns get hot the quoins are liable to fly out, or elevating screws run down, throwing the elevation out, and causing the shot to pass over the object. It may be asserted that one gun protected is equal to ten in the open, and a gun in the open is better than one badly protected by inflammable, splintering materials.

Taking into consideration then all the above advantages, I believe I am within the mark when I state that one gun covered by a shield is equal to 10 guns in a 3-decker. This would give a ship with 20 guns in shields a destructive power equal to 200 broadside guns in a 3-decker; but, as the latter has only 60 broadside guns, the comparison will be as 200 to 60, or 10 to 3 in favour of the shield-ship. I have then shown that three of these shield-ships would be equal to ten 3-deckers.

Let me next draw your attention to the relative outlay and expense of keeping these vessels in commission. The average cost of the shield-ship with the present iron ships building would be the same; but, taking broadside gun for broadside gun, the shield-ship would be by far the cheapest: for instance, I believe the largest iron frigates building are to cost £320,000, with 18 broadside guns, only 13 of which are protected by iron; but a shield-ship of the same size and cost would have a broad side of 20 guns, all of which are protected by iron.

I will now touch upon the great saving of manual labour, a point of no small consequence in these days, independently of the question of economy.

A gun carrying a 100-pounder shot in the shield can be worked by three men, but say five, viz. one to direct and keep the gun bearing on the object, two to load, and two to attend to the turntable and supply ammunition. The carriage is self-acting, the gun running in and out without being touched.

This carriage has already been tried, and so far succeeded, thus an enormous amount of manual labour is saved: but, as a relief and spare men for other duties would be required, we will allow 10 men to each gun, thus requiring 200 men for the shield-ship of 20 guns, whilst a 3-decker requires 1,000 or 1,200 men. One shield-ship equal to cope with and destroy three 3-deckers (as before shown) requires only one-fifth of a 3-decker's complement of men. Then with one 3-decker's ship's company 5 shield-ships are manned equal in power to 15 3-deckers, so that with the same number of men, wages, provisions, and manual labour as 3 3-deckers, 15 ships of the shield plan can be maintained equal to 45 3-deckers, making a saving in favour of the shields as 15 to 1.

The expense, however, may not be the greatest consideration. Our great difficulty in time of war will be to find men; therefore the saving of men here obtained will be a most important point. Why should we in the navy require the same manual labour to work the guns that we did in Nelson's time, when, in every trade and profession, such an enormous amount of labour is saved by mechanical appliances?

Having gone through my various plans of these shield-ships, I will briefly state the mode in which I would organise a force of these ships for our national defence. In these days of electric telegraph and motive power, intelligence of any hostile demonstration on our coast can be conveyed in a few seconds, and, on receiving the intelligence, floating bodies can be moved to any point at a certain speed in a given time. We know that steamers are built to run to New York in a given number of hours; that contracts are daily entered into for vessels to average a certain speed; why cannot we build vessels to traverse the shores of Great Britain at a given average speed? I would then, for our national defences, propose to have five of these shield-ships at Spithead, five at Plymouth, and five at the Nore, assisted by the 150 gun-boats which we already have; direct telegraph communication between these forces, the whole coast, and the Government.

These iron ships being able to move at the rate of 12 miles an hour, I think it would be a bold invader (even if our seagoing fleet were called away) who would attempt a landing with these 15 shield-ships and a musquito fleet of gunboats ready to concentrate their powers on him while in the confusion of landing; these 15 ships being able to cope with 45 sail of the present line-of-battle ships. Rafts, as proposed by me in the pamphlet alluded to, would also greatly assist in preventing a landing.

My adoption of this shield to land coast defences I will not now dwell upon, but will reserve it for a future period, as I fear that I have already trespassed too long on your patience. I will, however, remark that the same saving of space, manual labour, and expense, is obtained with regard to a fort as to a ship.

Before quitting my subject, I must, however, without mentioning names, express my gratitude and thanks to those by whose generous aid I have been able thus far to carry out my plans. The experiments which I hope eventually will be made on my shield at Shoeburyness (although much time has already elapsed) will bring my humble efforts to a certain test, and, although I would not speak too confidently, I am not without some grounds for my hope of success.

I have said I would not mention names, but I am inclined to depart from my intention, in order to do honour to the dead. Mr. Brunel, when in 1855 I showed him my shot-proof raft and shield, most liberally informed me that he had himself been planning shot-proof light draft vessels for service against the Russian forts; but acknowledged that I had hit upon the right thing, and that he should think no more of his own plans. He then gave me his valuable assistance, allowed his draughtsman to draw the plans of my shot-proof raft, and with his well-known generosity declined to receive from me any remuneration. His remark to me was "Go on, persevere; you only require a breech-loader to make your shield perfect."

On Sir William Armstrong's gun coming out I remembered Mr. Brunel's expression, and with a fresh impulse exerted all my energies to bring out this invention.

Now that other nations are building iron-coated ships, we cannot stop. In future our fleets must fight in armour; and supremacy afloat must depend henceforth on superior ability to produce the new ships required.

The first outlay for iron-coated ships will no doubt be enormous; but, looking to the future, and at the great strides we are making in rifled cannon and in motive power, the reconstruction of the *large* ships of fleets which decide the fate of nations, though a question with regard to the time of full accomplishment, is inevitable. Three-deckers and stationary guns on the present system of fortifications for coast defences will become obsolete, and we shall look upon them as we now do upon the old stage-coach, which is only used when we can get nothing better. The most economical ship will be that which is the most invulnerable and the most durable.

Friday, July 13th, 1860.

Gen. SIR JOHN F. BURGOYNE, Bart., R.E., G.C.B., in the Chair.

THE DEFENCE OF LONDON,

By Colonel SHAFTO ADAIR, F.R.S., A.D.C. to the Queen.

THE occasion on which I am permitted to address this meeting is so peculiar that, before proceeding to the technical questions which will arise, I think it will not be inopportune to remark on the reasons that have called us together. The Report of the Royal Commission on the National Defences is already familiar to every one present, as it will be to the entire population of the empire; and to all who, in every land, take an abiding interest in the maintenance of the British dignity, security, and renown. But when the Report of the Commissioners was published, there was an omission on one point of highest interest, but not the less capable of a most satisfactory and clear explanation; namely, the absence of any allusion to the defence of London. And, in truth, if the question of the defence of London had been connected simply with a military arrangement proposed by the Commission, I should not, on this occasion, have intruded my opinions, or have impugned the deductions of soldiers, than whom none are more competent to propose measures the most desirable for the military security of this country. But, inasmuch as the defence of London trenches on a larger question than that raised in the discussion of warlike preparation, and is too extensive a subject to be covered by the instructions of that Commission, I have thought, and the Council of this Institution have been pleased to sanction the idea that I entertained, that it would not be altogether inappropriate for one, albeit not a professional soldier, to enter on a subject which, although mainly embracing military considerations, yet in large proportion was to be weighed and judged in dependence upon the exertions, the sacrifices, and the labours of the population at large. Therefore it is that, having examined with much care and with exceeding admiration the opinions of the distinguished soldiers who have elaborated the plans set forth in the Report of the Commission of Defence, I desire to be excused of rashness in taking up the question where they have left it, in accordance with the terms and spirit of their instructions, and in bringing forward for public discussion such ideas as have occurred to me with reference to the defences of the metropolis. And since I shall not have time on this occasion to detail at length the reasons which lead me to particular conclusions with respect to any threatened attack upon London, I must request you to admit certain assumptions which I have advocated, and I hope justified here, and at other times, but which I have not now the opportunity to set forth at length. Let it then be assumed that the command of the seas has, for a season, passed from us; let it be assumed that an enemy has landed in

force, prepared to take the alternative routes by which the metropolis may be reached. For, indeed, it seems to be generally believed that a march on the metropolis would be the special object of an invading force. But I may detain you for one moment by referring to the plan before me, in which I have traced in shaded divisions, in supplement of that oral explanation which I am compelled to postpone, the strategic justification of my belief that specific and well-ascertained routes must be adopted by an enemy marching on the capital. I find on the south coast of England three objective points of attack—Dover, Portsmouth, and Plymouth. I have given my reasons in my lecture on the defence of Portsmouth, for asserting that it is perfectly possible to surround these objective points of attack with districts of defence, such as may compel an invader to choose the routes interposed between the borders of these well-defined districts; and I have also pointed out the districts in other parts of England which would be liable to incursions of diversion, as they may be called, in order to draw off and distract the movements of the corps assigned for their defence from acting in repulse of the main attack which would be precipitated on the metropolis. Assuming, therefore, that London is the point at which the attack is directed—that the Portsmouth, the Plymouth, and the Dover districts furnish each its contingent of defence, which render it difficult, if not dangerous, for an invading force to engage in direct battle operations within their limits, there are evident points of disembarcation eastward and westward of the central fortress, which are precisely such as would be selected by an enemy who was determined on fighting battles of manœuvre. Landing to the eastward and westward of Portsmouth, they would soon find themselves in a district adapted to the tactics of practical warfare to a degree scarcely to be found in any other part of England. Manœuvring to the northward, the valley of the Thames is within a few marches. It is especially suited to the purposes of an invading force, first, because the rich district would support the invader's troops, and the Thames would give an easy mode of bringing up those indispensable stores which encumber and delay the advance of an army so much. And there is another reason which I will add, that, inasmuch as an enemy advancing on the capital from the south-east would be observed by the forces garrisoned at Dover, would be watched on the flank by the reserves within the lines at Chatham, and would also have to hew a desperate way through the eight difficult passes of the North Downs, the longer route would be adopted as the best suited on the whole to an aggressive strategy based on rapidity of advance, exaggeration of strength, and superiority of tactics.

In the progress, then, of this hypothetic invasion, it may be assumed that a great battle has been fought with or without decisive success, as the case may be, on the one part or on the other, but that the invader after this battle is still in sufficient force and sufficient heart to present himself before London. Presenting himself before London, I see no reason for doubting the issue, whatever the result of the previous conflict may have been; and it is my duty this day to give my reasons for that opinion.

Several plans have been suggested for the defence of London, but there is one fatal deficiency common to them all—the want of confidence in the inhabitants of the capital to achieve their own safety. Strategic points

are selected without much certain reference to their individual value, as if the question was of studding a Flemish frontier with fortresses, where the soldier should be everything, and the citizen nothing. In this system I cannot but see the rejection of a mighty element of strength and safety; for in invasion, the place for the trained soldier is in the army of manœuvre, and of the citizen in the army of reserve. One plan has the authority of great names, of soldiers of large experience and military knowlege, well and honourably known to the ranks of the British Army, which consists in placing strong remote forts at intervals around the metropolis. This system has found much favour; but I confess my inability to assent to the proposition upon which it is based. I think there is, first of all, this great danger, that, when defence is based on remote points, if the interval between those points, which it would be exceedingly difficult to guard in proportion to the importance of the points themselves, is once penetrated, all would be considered to be lost. Now, I repeat again, that, whatever the result of any battle, London, if properly organised, has no reason to be discouraged; for, in my deliberate judgment, looking over the neighbouring and adjacent country carefully, considering the temper of her people and her power of organisation, I dare affirm that London is naturally the strongest capital in Europe. My ground for this opinion shall be briefly detailed. If the topographical circumstances of London be reviewed, it will be remembered that the capital is formed on a parallelogram, the northern side whereof is drawn along the ridges of the Highgate and Hampstead Hills, sinking into the great western plain at Harrow; and that the southern line passes over Shooter's Hill (speaking simply of the London district) to the bend of the Thames, which is guarded by Kingston, Richmond, and Brentford. The east approaches are covered on the north side of the Thames by the marshes of the Lea, on the south by the marshes lying to the eastward of Woolwich, considered apart from the mass of Shooter's Hill. To the west, in the valley of the Thames, lies the most difficult portion of the London district to guard, and the one against which, on my hypothesis, the whole strength of an invading force would be hurled. That point, therefore, is one, and that line is one, that it especially behoves us to regard and to defend. And, when I said that London was the strongest capital in Europe in its natural advantages, I referred especially to the impunity which may be secured to London from that agent which produces so terrible an effect on the population of beleaguered cities; I speak of the harassing and dispiriting effects of the continual stroke of vertical fire; I speak of the misery that arises to populations driven from a quarter exposed to the enemy's fire into another already overcrowded; I speak of the growing accumulation of wounded and of sick, who are crowded in the time of such calamities in vast numbers in hospitals; and I conclude that, from the conformation of London, it is above all other capitals most easily defended from such a scourge. For, to neutralize the unbearable evils of a fire so terrible, the one and the secure means is to render bombardment impracticable, by keeping at a safe distance the batteries that vomit forth their host of plagues.

I may say once for all, that my principal design in encircling London with forts which are not of a capacity too great, or of too intricate detail for the occupation of troops of reserve, at as close a distance as safety from

vertical fire will allow—the reasons for my preference of this distribution of force to the employment of large forts at a distance—are these: I do not wish London to remain in a silent anxiety endeavouring to ascertain how the battle goes from the rise or fall of the distant cannonade; I do not desire that London should hang in suspense on the chances of a remote struggle. The defence of London should be bound up intimately with the spirit and the heart of her people; I desire that each cannon shot and each volley should raise her spirit to a higher pitch, and brace the nerve of her defenders to efforts each greater than its preceding one, until the supreme and conquering charge crown the conflict. Let her know the extent of the defence of which she is capable, that she may not know, if that defence be not prolonged, the extent of the evil to be endured.

With regard to the trace, that is a matter, of course, open to future suggestion; but, generally, and, considering the quality both for attack and defence of the troops we should have to deal with, and the nature of the assault *de vive force*, and of the resistance by musketry or carronade, I should say that, where the works are of the more important character, they should be as much as possible on a polygonal trace, with a redoubt *en caponnière*. Where the works are of a less decisive trace, there I should propose to take modifications of the old bastion system.

The armaments should be of mixed calibres; one-third of 8-inch guns, one-third of 32-pounders, and one-third of 32-pounder carronades, in order to obtain by the union of the 8-inch and the 32-pounders an identity of charge, and by the union of the two qualities of 32's an identity of projectile, and consequently greater simplicity. I am also enabled thereby to diminish the strength of the gun detachments. If the whole of the guns were of the same calibre, the detachments would require to be so strong that they must draw enormously and disproportionately on our resources; neither would they be suitable for all the cases that might arise, because, inasmuch as these forts are rather works of occasion, so to speak, than works designed to maintain a long siege, an attack would probably be of a nature that would occasionally require a proportion of ordnance handier and more quickly managed than the 8-inch on a traversing platform, or than even a 32-pounder on a garrison-carriage; and therefore the carronade is introduced to resist these attacks.

Commencing from the eastward, I propose, after the example of Alfred, to inundate the valley of the Lea from Tottenham to the Thames. Beyond this inundation I project a star fort on the high ground at Barking, nearly resting on the inundation, which would cross its fires with a fort protecting the access from the Eastern Counties Railway, and, at the same time, keep down any attempt to molest Woolwich from the low-lying ground between Barking and the river. Fort Barking should be armed with thirty guns. The garrison details will be given in the Appendix (A).

Now, since London is shielded on the south side by the hills of Kent and Surrey, and on the north side by the hills of Middlesex, it will be seen that, if we can detain an advancing enemy on the southern and northern slopes respectively, a very large power of mischief is withdrawn. I have, therefore, on the plan, drawn the line of works with which I propose to protect the northern, eastern, and southern side, and also a line of works

and batteries with which I would close the entrance to London from the westward, by the approaches in the Valley of the Thames.

Passing from this fort of which I have spoken, I proceed to a similar one, Fort Stratford, of 30 guns, resting on the Eastern Counties Railway. I shall hereafter point out the advantages that I propose to derive from the inner line of railway which traverses London from East Woolwich to North Woolwich; and I would here remark, that many of these works have been placed, especially on the south side, so that their rear will be covered and their flanks commanded by the artillery fire that may be projected by aid of this circular railway. Passing to the north-west, we come to Low Leyton, where the Leyton Redoubt of 30 guns rests on the River Lea, and on the inundation. The ditches are supplied from the waters of that river, and it crosses its fire with Fort Stratford and with Fort Stamford of 20 guns on Clapton Common. Fort Stamford is placed on the low ground whence the Stamford plateau rises from the marshes, in order that the defence of the Eastern Lines may thus be completed, and also a powerful fire lent in aid of Fort Hornsey, of 20 guns, which I have placed in such a position as to cover the reservoirs through which London draws from the springs of the New River a large proportion of its water supply.

I now come to the difficult point of the occupation of the ground about Highgate. Passing along the plain to the north-westward, it will be observed that on the left the spurs of the Highgate range project themselves into the country north-east, terminated by a hill overhanging the railway, and called Mount Pleasant, in the south-east direction, and by Muswell Hill on the east. With all an artilleryman's distrust of a very high elevation and excessive command, I doubted whether it were safe to draw defensive constructions close to the crest of the hill; but, bearing always in mind how necessary it is to protect London from the scourge of vertical fire, the better course appeared to advance, along the axes of these hills, two semi-elliptical works, Forts Muswell and Mount Pleasant, of 25 and 20 guns respectively, of a trace determined by the ground, to cross their fire, be connected by earthworks, and thus detain the enemy at a safe distance. Passing from Highgate, the ground forms a natural *glacis* to the northward, sloping upwards to Hampstead Heath. Hampstead Heath is a very favourable position for defence, and must be carefully secured by double lines of earthworks.

In considering the treatment of Hampstead, I am indebted to the skill of Lieut.-Colonel Alcock, R.E. Middlesex Militia, for suggestions on fortifying that hill. He observes very truly, that on the upper summit is a space for a work of 15 guns, giving extensive command over the valleys radiating from that point, and that the fire of that position may be combined with that on a lower hill called Child's Hill Redoubt, and armed with 30 guns, marked as a semi-circular work on the plan. Those combined works are of importance from their position, and capable of prolonged defence, and are designated the Hampstead and Child's Hill Redoubts. A country is now entered upon especially suited for two purposes: for manœuvre by skirmishing in force, and with heavy reserves; and secondly, for fighting a battle with field artillery. It strikingly resembles the famous field of Bautzen, which was the scene of a protracted artillery battle, and contested with such skill on the part of the Allies that they were enabled to

withdraw every gun at the conclusion, to the astonishment of the Emperor Napoleon. As the slope of Hampstead is descended towards the Edgeware Road, in front lie the Brent Reservoirs. In conformity with the obligation which I have imposed upon myself of protecting reservoirs wherever possible, I propose to construct at the north-east angle above the Brent Reservoirs the Brent Redoubt, an irregular work of 30 guns, which should protect that basin.

The most difficult district, so far as regards a battle of manœuvre, is now approached. Between the flat-topped hill rising immediately above the Brent Reservoirs and the Harrow Road an eminence will be observed, culminating in Wembley Park. On that point I would construct Fort Wembley of 30 guns, a work which shall give a reverse fire, if the enemy should penetrate athwart or pass round either point of the Brent Reservoirs, and also sweep the country to the north-east, and in front of the separate chain of field works intended to cover Harrow. It should also be kept in communication with the next and most remarkable point in the western neighbourhood of London, where the undulating range terminates in a bluff crowned by Horsington Wood. It is a very strong position, about two miles from Harrow, and closes the whole of the level ground on the north side of the river Brent, and, in fact, observes the country to the bridge-head at Brentford. The southern face is of a steep and almost scarped character. It has capacity on the summit for the construction of a large fort, and I think should be used as a depôt, and considered the right point of *appui*, facing outwards to the lines of the western defence. The country at the foot is marshy, and is susceptible of inundation, being traversed by the waters of the Brent, and is partially covered by the Grand Junction and Paddington Canals. Now, it may always be observed that in defensive warfare very great use can be made of inundations, and that they are invariably turned to the profit of those who know the country, and who can direct them at pleasure. I should, therefore, taking Horsington Hill as a depôt, and as a main point, the key in fact to the position, arm that position more heavily than any other, and 80 guns should be assigned to Fort Horsington. Fort Greenford, placed within the loop of the Brent, would require 60 guns. Fort Ealing, projected on the flat in front of that town, should mount 60 guns, while the line of fire would be continued by four pairs of batteries armed respectively with 10 guns to the bridge-head at Brentford. Passing through the flat country, where the works, nearly as far as Ealing, are defended by water, and thence by the ordinary appliances of engineering skill, the lines reach Brentford. Brentford is protected by a bridge-head mounting 20 guns, as is Richmond Bridge by 20 guns. Kingston, lying on an exposed salient, is covered by a bridge-head with a strong bastion trace, and mounts 40 guns. For if the assumption be correct that the weight of invading war would be brought on the west of London, it is important to guard this point with as heavy a mass of fire as possible. In the rear, on the slope of the hill above Ham Common, Fort Richmond, a strong work of 20 guns, planted at the apex of the angle formed by the western and southern sides of Richmond Park, would connect the western and southern lines of defence.

Defence of Harrow.

And at this portion of the London lines I turn to the special defence of Harrow. The position is too valuable in the military point of view, and the ground too highly placed, in the national estimation, to be left in peril of foreign occupation, by being excluded from the metropolitan system of defence, however difficult the defence may be. The long slope of Harrow, projected nearly at right angles from the north-western angle of the London lines, rises in a continuous ascent for a mile and a quarter to the highest point crowned by the parish church. The flanks of the hill gradually increase in steepness, until the rapid slope of the north-western face projects boldly, overlooking the plain of the Thames to the distant hills of Surrey and of Berkshire, and overtopping the nearer heights of Stanmore to the north-east.

The most appropriate system for the defence of Harrow, on the special ground of the military value and of the national character of the spot, will be by batteries, and not by works of construction on a regular trace. For works casemated or otherwise of a permanent character could not be constructed without obliterating the special distinction of the hill, as consecrated to national education. But this strong post of vantage may not be the less efficiently secured.

The formula of defence is this: heavy earthen batteries, loopholed and stockaded posts, and an extensive system of rifle trenches. The earthern batteries should have no great command, but have an uniform mutual relation of defence. The position of the batteries should be determined by a contouring line, to be drawn at such an elevation on the slope as would give an angle of depression of 4° on a point distant 700 yards from the foot of the rising ground on which the battery is to be placed. The general line of the zone of artillery fire would commence on the Greenford Road, one mile from Harrow, and passing below the south-western shoulder of the hill, would sweep to the north of Roxeth, and thence to the junction of the Kenton Road, round the northern face of the hill. The line would follow the hollows of the hill until it reached the cross road connecting the two approaches from London, and passing to the westward complete the circuit. The right and left rear would be connected by field-works with Fort Wembley and Fort Horsington.

For this line of defence nine pairs of heavy batteries, of the construction of those on the Hilsea lines at Portsmouth, would suffice; they should be armed with twenty guns, each pair, and be determined in position by the re-entering angles or loops of the contouring line—for the southern and western faces six batteries; for the eastern face six batteries, and the northern front should be formidable with six batteries, of which two should be advanced on either flank, to give a decisive check by flanking fire to attacks on the lateral fronts.

The rear of these batteries should be closed by strong musketry redoubts, which should in turn be open to the rear to fire from loopholed houses and stockaded posts. And from battery to battery, and along every advantageous slope of ground, should be traced rifle trenches formed by

excavation, with the earth thrown to the front, as *glacis*, and not as *parapet*.*

Every position would thus be threatened in turn if it were necessary to withdraw the defenders from the lower levels. Finally, the Volunteer Corps of Harrow should have this defence specially assigned as its duty.

I now proceed to treat of the southern lines of defence, whereon I place the works, not symmetrically indeed, nor at equal intervals, but, as I have throughout, according to the circumstances of the ground, determining the projection of their face as they may be required to sweep any particular point of approach with their fire. Now, those who recently attended the practice of the Volunteer Rifles on Wimbledon Common will remember how rapidly the ground falls in front of that position. Since it is necessary to occupy that plateau, it appears desirable that a work to be called Fort Wimbledon should be constructed in the immediate neighbourhood of the present rifle ground, which would answer all the conditions proposed, namely, sweeping and searching the ground in front and flank with 40 guns, and keeping an enemy at a sufficient distance from the inner district, liable to insult from vertical fire. From Wimbledon, following the southern slope of the hill, the very remarkable ridge which divides the waters of the Wandle from the Sydenham Plateau is reached. On the level ground immediately above Tooting Common, on the ascent from the village below, I should propose to place Tooting Redoubt, another substantive work of 30 guns, to be kept in connexion with Fort Wimbledon by earthworks distributed through the plain, across the course of the Wandle. The ground at many of those points is remarkably strong. And there, again, a water defence may be adopted very successfully.

From Tooting, following the indications given by the slopes of the ground, we arrive at the Beulah Redoubt, an irregular work of 30 guns, which will be seen to the north-west of Beulah Spa. This work is adapted to the character of the eminence which it crowns, and is designed to maintain a communication with an advanced work, the Anerley Redoubt, of 20 guns, in front of the Crystal Palace, of an irregular shape, resting partly on the Railway, and partly on the Anerley Ponds.

We have now lying in front of us the great plain of Kent. From these heights the general line of ground is most clearly and distinctly to be traced, and the approaches of an enemy calculated. I should therefore across the valley on the other side of the Ravensbourne river, on a gentle slope which rises at a distance of one mile and a half in an air line from the Crystal Palace, place Fort Ravensbourne, a substantive work of 50 guns; and the line of defence would be closed by Fort Woolwich, a work of 80 guns, with its rear resting on the Dover Road, in the loop of the road near Woolwich Common. With regard to fortifying Shooter's Hill, that point I have not taken into consideration. The occupation of Shooter's Hill is a matter of high engineering moment and skill, and would require a very considerable outlay. It must, in fact, be a fortress of itself, and therefore does not enter within the scope of these suggestions.

* An illustration of the rifle trenches may be found in the trace of the ascending sap at the siege of Burgos.

I would request the meeting to bear this in mind, that the works I have pointed out are not the only works I desire to construct. These are the permanent works which it is essential to construct, and the fire of which it is necessary to determine. But the intervals must be consolidated by such field works as can be thrown up with comparatively little labour, and would by their cover enable the troops detailed to maintain the musketry fire which is necessary for a complete defence. Therefore I differ from the advocates of the *enceinte continue* at Paris and elsewhere. I propose to leave only the forts *en permanence*, but in time of necessity to connect them by means of field works.

It is a very just objection, that the requisite guns and troops are seldom mentioned in detail of plans; and, at the risk of having the calculations disproved, and in the design of submitting them to critical analysis, I commence by the calculation that 870 guns will be a sufficient armament for these works, exclusive of the defence of Harrow, which must be special, as has been already shown. From the combination of qualities of ordnance which I propose, the strength of the artillery detachments may very materially be kept down, as may be reasonably borne in mind in calculating the strength of artillery required for the service of the London lines; and, inasmuch as the general defence of the lines of London would not be a matter of siege, and of protracted firing and attack, the service can be carried on with fewer reliefs than in a garrison which had to resist on a front of attack assaulted according to the rules of art. Therefore, it appears to me, that seven men per gun would furnish a standing garrison sufficient to justify us in undertaking the defence of the works most likely to be attacked *de vive force*. Perhaps the higher proportion should be preserved for such works as from their importance might be more formally attacked. The infantry defence may be calculated on a low scale at 10 men per gun, being intended simply to occupy the works while operations are going on, and their number must be inconsiderable, and should be inconsiderable on this principle—that we are occupying works which are to be only temporary obstacles, and which should be so constructed as to allow every disposable man to be placed in line of battle, and available under the hand of the supreme military authority.

Now, having surrounded London with works, the question arises, what are the resources for defence? The assumption which I have always insisted upon is, that the primary defence of England should be a defence by local forces specially trained for the protection of a particular district, wheresoever the attack may fall, in order that our limited manœuvring force may be available in every direction in which it is required. Thinking thus, I hold with regard to the metropolis, that the metropolis should be prepared to stand or fall by its own substantive defence, and not in consequence of any operations elsewhere. We know what a gallant, and ready, and available spirit has arisen throughout the country in development of the volunteer movement. We see in these levies the earnest of a true soldier-like, manly, British determination to do their duty. They show in their organisation and by their bearing, the consciousness that they have undertaken a duty which the country required should be performed, but which could not be discharged by existing means. We know what sacrifices many in their

ranks have made, and those especially to whom the time given to their occupations is valuable, and whose leisure hours have also been placed, without fee or reward, at the service of the State. It has been a matter of some little difficulty to arrange the proportions of these volunteer forces that we may expect to draw from the general population. I have found the greatest assistance from the accurate statistical tables prepared by Lieutenant-Colonel Kennedy, in his valuable memoir on "National Defensive Measures, their Necessity, Description, Organisation, and Cost." To him I am indebted for suggestions showing how the volunteer forces may best be disposed in proportion to the military demands on the population. I have, therefore, adopting his principle, placed the masses of volunteers in such positions as they might advantageously occupy in the event of a call for their services. I have not attempted to distribute the general body by regiments, which would complicate the plan, but, observing the calculated density of the population, I have assigned to them alarm-posts in their respective localities, which would be points whereon the regiments, brigades, or divisions would form upon the first alarm. The corps would then be available in the direction for any special purpose, and would thus be prepared for any movement. The tabular arrangement is shown in the Appendix B.

It is evident, as has been shown, that this question is removed beyond the province of purely military speculation. It should be maturely considered, whether the volunteer regiments, armed, drilled, and disciplined, may not have an enlarged scope given to their organisation and some additional duties assigned to them, in the interest of their special service, which are not ordinarily devolved on regular troops, or on troops in the field. For instance, as I have shown, one great evil to be dreaded is the vertical fire that the enemy would endeavour to pour on the metropolis, with which he would hope to alarm the population, and, hence through their fears, to extort a capitulation of London. Now, in the firm confidence that I have in the power of organisation enjoyed by the English people, and in their present readiness to adopt any sound suggestion, and their firmness in carrying it out, I maintain that even this evil, so awful to contemplate, may be modified, minimised, nay, reckoned as an ordinary incident of battle.

It is always satisfactory to draw some instruction from the occurrences of former times under similar circumstances, and with a population of identical character. For it would almost seem as if the precedents of the reign of the great Queen, in anticipation of the Spanish invasion, were, with other glorious incidents, to be repeated in these later days. Now, it is very remarkable that in the accounts of the armament of Elizabeth to resist the invasion, a proportion of artificers is always combined with every armed body. There are pioneers and artificers of all trades, wheelwrights, carpenters, blacksmiths, all specified in particular and accurate proportions, detailed to accompany every body of armed men. Let, then, every volunteer force embodied under a regimental colonel or field officer have a volunteer engineer corps attached. Thus an opportunity would arise of drawing on the valuable class of men to be found among the steady resolute artizans of the metropolis. And I believe that such an organisation would be acceptable to the body of Civil

Engineers. That is one preparation. I would suggest, also, that to guard against the ill effect produced by working on the fears of the population through the threat of laying districts and suburbs in ashes, one fire brigade, with engine and horses, be attached to every district, and planted at every alarm post. Supposing, then, that any portion of the metropolis was on fire, it should be the special duty of the Engineer volunteer officer commanding at that point to hasten with a proportion of volunteer Sappers to the conflagration, extinguish the fire, and take such measures as might be necessary. By thus distributing the volunteer regiments or corps each to its defined district, and by assigning to each a special object and duty, confidence would be given to the people, and the dangers and terrors of a bombardment would be neutralised and dispelled by a simple and timely arrangement. If the people do not clearly perceive the manner in which they are to be defended, and by what arrangement their security is to be ensured, panic will arise, confusion will double every difficulty, and the military authorities will have to deal over and over again with the only military difficulty worth speaking of in England, that is, the process of clearing the front of non-combatants, to meet which special provision must be made. If the front be cleared of non-combatants the English soldiers will fight as they always have fought. But we must be prepared against the danger not only of reverses in the field, but against that greater danger which arises from the panics of unarmed and helpless multitudes in towns. And to combat this peril I make a special provision. I spoke of the difficulty of clearing the front of non-combatants. I believe that the terror which an enemy would hope to generate in the confused masses, by the approach of an invading army, would be held to be one of the most powerful weapons of invasion. This expectation it is our duty to dispel. I may be supposed to theorise, to estimate too lightly, or even to overlook difficulties which must inevitably arise in dealing with large masses of people; but, considering the perfection at which our railway communications have arrived, the speedy means which are enjoyed of connecting one part of the country with another, it is doubtless feasible, when one front of London is invested (for it is scarcely possible to suppose that London can ever be entirely invested), by due organisation to pass the whole of the non-combatants from the front attacked, through London, to the rear, into districts, towns, and places prepared for their reception, on which they shall be directed by the aid of the wide-spreading system of railways, which, radiating from London, traverses England in every direction. And so soon as those whom we desire to withdraw from the horrors and miseries of war should be conveyed far from the scene of conflict, there would be clear space for those who would alone remain in the front to defend their hearths and homes. I make this suggestion confidently, and believe it to be perfectly practicable. I think, Sir, you who saw to what extent the pervasive organisation of England was carried, in contending in the depth of a severe winter with the Irish famine, will have that confidence in the national power of combination to admit that such a plan is neither rash in conception nor impracticable in detail.

ranks have made, and those especially to whom the time given to their occupations is valuable, and whose leisure hours have also been placed, without fee or reward, at the service of the State. It has been a matter of some little difficulty to arrange the proportions of these volunteer forces that we may expect to draw from the general population. I have found the greatest assistance from the accurate statistical tables prepared by Lieutenant-Colonel Kennedy, in his valuable memoir on "National Defensive Measures, their Necessity, Description, Organisation, and Cost." To him I am indebted for suggestions showing how the volunteer forces may best be disposed in proportion to the military demands on the population. I have, therefore, adopting his principle, placed the masses of volunteers in such positions as they might advantageously occupy in the event of a call for their services. I have not attempted to distribute the general body by regiments, which would complicate the plan, but, observing the calculated density of the population, I have assigned to them alarm-posts in their respective localities, which would be points whereon the regiments, brigades, or divisions would form upon the first alarm. The corps would then be available in the direction for any special purpose, and would thus be prepared for any movement. The tabular arrangement is shown in the Appendix B.

It is evident, as has been shown, that this question is removed beyond the province of purely military speculation. It should be maturely considered, whether the volunteer regiments, armed, drilled, and disciplined, may not have an enlarged scope given to their organisation and some additional duties assigned to them, in the interest of their special service, which are not ordinarily devolved on regular troops, or on troops in the field. For instance, as I have shown, one great evil to be dreaded is the vertical fire that the enemy would endeavour to pour on the metropolis, with which he would hope to alarm the population, and, hence through their fears, to extort a capitulation of London. Now, in the firm confidence that I have in the power of organisation enjoyed by the English people, and in their present readiness to adopt any sound suggestion, and their firmness in carrying it out, I maintain that even this evil, so awful to contemplate, may be modified, minimised, nay, reckoned as an ordinary incident of battle.

It is always satisfactory to draw some instruction from the occurrences of former times under similar circumstances, and with a population of identical character. For it would almost seem as if the precedents of the reign of the great Queen, in anticipation of the Spanish invasion, were, with other glorious incidents, to be repeated in these later days. Now, it is very remarkable that in the accounts of the armament of Elizabeth to resist the invasion, a proportion of artificers is always combined with every armed body. There are pioneers and artificers of all trades, wheelwrights, carpenters, blacksmiths, all specified in particular and accurate proportions, detailed to accompany every body of armed men. Let, then, every volunteer force embodied under a regimental colonel or field officer have a volunteer engineer corps attached. Thus an opportunity would arise of drawing on the valuable class of men to be found among the steady resolute artizans of the metropolis. And I believe that such an organisation would be acceptable to the body of Civil

Engineers. That is one preparation. I would suggest, also, that to guard against the ill effect produced by working on the fears of the population through the threat of laying districts and suburbs in ashes, one fire brigade, with engine and horses, be attached to every district, and planted at every alarm post. Supposing, then, that any portion of the metropolis was on fire, it should be the special duty of the Engineer volunteer officer commanding at that point to hasten with a proportion of volunteer Sappers to the conflagration, extinguish the fire, and take such measures as might be necessary. By thus distributing the volunteer regiments or corps each to its defined district, and by assigning to each a special object and duty, confidence would be given to the people, and the dangers and terrors of a bombardment would be neutralised and dispelled by a simple and timely arrangement. If the people do not clearly perceive the manner in which they are to be defended, and by what arrangement their security is to be ensured, panic will arise, confusion will double every difficulty, and the military authorities will have to deal over and over again with the only military difficulty worth speaking of in England, that is, the process of clearing the front of non-combatants, to meet which special provision must be made. If the front be cleared of non-combatants the English soldiers will fight as they always have fought. But we must be prepared against the danger not only of reverses in the field, but against that greater danger which arises from the panics of unarmed and helpless multitudes in towns. And to combat this peril I make a special provision. I spoke of the difficulty of clearing the front of non-combatants. I believe that the terror which an enemy would hope to generate in the confused masses, by the approach of an invading army, would be held to be one of the most powerful weapons of invasion. This expectation it is our duty to dispel. I may be supposed to theorise, to estimate too lightly, or even to overlook difficulties which must inevitably arise in dealing with large masses of people; but, considering the perfection at which our railway communications have arrived, the speedy means which are enjoyed of connecting one part of the country with another, it is doubtless feasible, when one front of London is invested (for it is scarcely possible to suppose that London can ever be entirely invested), by due organisation to pass the whole of the non-combatants from the front attacked, through London, to the rear, into districts, towns, and places prepared for their reception, on which they shall be directed by the aid of the wide-spreading system of railways, which, radiating from London, traverses England in every direction. And so soon as those whom we desire to withdraw from the horrors and miseries of war should be conveyed far from the scene of conflict, there would be clear space for those who would alone remain in the front to defend their hearths and homes. I make this suggestion confidently, and believe it to be perfectly practicable. I think, Sir, you who saw to what extent the pervasive organisation of England was carried, in contending in the depth of a severe winter with the Irish famine, will have that confidence in the national power of combination to admit that such a plan is neither rash in conception nor impracticable in detail.

And for this service the admirable bodies of Metropolitan and City police might be trained. Their familiarity with the condition and daily life of all classes would give them the means of effectually putting in motion the inert mass, which would not be manageable under other agencies. To them also would belong the duty of maintaining the peace and security of the metropolis, certain to be troubled by the ill-disposed classes, who always expect plunder and license in periods of national peril.

Let us now consider the defence of London with an enemy at its gates. It is fortunate for those who entertain my opinion, that London deserves an unhesitating and protracted defence, that we already possess, as matter of history, the account of the successful defence, or rather of the relief, of an almost open town under more difficult circumstances than could probably be found twice in the annals of war. I allude to that great feat of arms performed by the Emperor Napoleon when he relieved Dresden, overmatched as he was in numbers, overmatched as he was in guns, and overmatched as he must have been but for his genius, his resolution, and the energy of his soldiers—in the moral power that the enemy brought to bear against him in the campaign of liberation. If the enemy, having pierced the line of works I have detailed, were in possession of the heights of London, and thence looked down, with the intention of fighting their way into its streets, I say the defenders of London would not be in so bad a plight as St. Cyr was, when, with his 20,000 men, he threw himself into Dresden, knowing that the Emperor would come to his aid; and how gloriously the Emperor did assist him, the historian has recorded as an example of what may be done in the defence of towns in all times. Dresden was almost an open town, merely surrounded by shattered walls, so imperfect in its fortifications that it was requisite to strengthen it by five large redoubts. In this Dresden 136,000 men held at bay and repulsed 166,000 men with 500 guns. The front of that battle extended for six miles and a half; but, again, the French Emperor was equal to the occasion, his soldiers seconded him, and the result was the disastrous retreat and rout of the Allies. Therefore it is that I say, whatever might be the condition of London, hemmed in as she might be by the masses of an invading army, there can exist no reason for despair, no reasonable excuse for abandoning the capital, no apology for deeming that it would be wise to purchase with our gold that which we could not defend with our swords.

I do not wish to speak with the exaggerated feeling that may arise when we consider with how great a calamity this nation might be threatened; I desire simply to deal with the plain mechanism of military resistance; I mean to prove what resistance, by works of construction, may be prepared; and I indicate the powerful means of resistance which may be anticipated from the support of your people. And I have endeavoured to show (by clearing thoroughly and decisively the field for the exertions of fighting soldiers), that if the disastrous event of the leaguer of London should ever occur, it may safely be left to history to say that the Russians were obliged to abandon and to burn Moscow in their distress, but the English remained and fought on their own ground.

Now, with regard to those details of interior defence, to which I have partially alluded, I speak of the zone of railways, which, beginning at North Woolwich, penetrates and surrounds the central portion of the metropolis on either bank, even to West Woolwich. I divide this zone into artillery districts. It is a point which I have discussed upon former occasions, and the distribution will be thus: I would make one artillery district from North Woolwich to the Stratford Station; a second artillery district should extend from the Stratford Station to the West London Junction; from the West London Junction to the banks of the Thames should give a third; a fourth should be drawn from thence to Clapham Station; from Clapham Station to Norwood Hill would form a fifth; and from Norwood Hill to Woolwich would complete the zone of artillery defence encircling central London with a second rampart. Now it is not that a railway is in its construction powerful for defence, for, in fact it may rather be called a line of movement than a line of defence, but that I would place on this curved trace of railway, guns moveable from point to point as occasion might arise. The stations projecting from the railway might be called points of emergence, on which to direct such field guns, stores, or troops, as might be required on a sudden change of front, or increase of attack. Such an adaptation is feasible, and adds, moreover, materially to the strength of those works near which the zone passes.

There is another point on which I would dwell in respect of the volunteer system. Admitting the axiom, that the standing defence of England is that by local forces acquainted with the particular districts, it is essential that volunteer corps should be acquainted with not only their own district and alarm-posts, but also with the nature of the country which might lie in their front when once they had quitted the suburbs of the metropolis. I can imagine cases (but it is scarcely worth while to particularise) in which the defence of London would be conducted with much greater success by soldiers accustomed to a particular district than by those who are strangers to the locality, and who had merely the ordinary rules of military service for their guidance. The local features of London, and especially of Western London, are very peculiar. There are large and well-defined districts broken up into manageable divisions of defence by the great thoroughfares that penetrate the capital. For instance, one side of our great thoroughfares might be occupied in force, and a defence developed against an enemy attempting to penetrate into the interior. It would, therefore, be advisable that to every great division, or independent corps of volunteers, field-guns should be attached, for the purpose of ultimate defence; because I hold that under no circumstances are we justified in capitulating for London. I repeat my belief, that we can rapidly and easily, with our organisation, remove the non-combatants from the danger in which they would be placed, and in which they would naturally look for sympathy and protection; and then, wherever the weight of attack may fall, I say we shall have no reason to despond for the fate of London.

And perhaps I dwell more on this subject because I am aware how little the English determination has been understood elsewhere. Because we do not proclaim without ceasing, a resolution to do that which falls to our lot in the shape of duty, it is often supposed that we have either lost

the power, or at least the spirit, which cares for the performance of great things. It is well that it should be known, that Englishmen carefully and deliberately adopt the resolution, that London is not to be taken; that we will neither hear in London of the removal of our Government, our Courts, or our Parliament; nor of the ransom of the City.

I would briefly remark here, that the zone of defence passing through these forts is about fifty miles. It is no very great extent to fill in, or make complete in the intervals between the forts, by field-works. The zone of radiation of fire covers 75 miles. And on this projection there are but three points, not included within a circle traced on a radius of one mile from a work, or, which is equivalent, from a point on a railway, at which guns might be placed in battery. These breaks measure respectively 700 and 1,000 yards. Consequently field-works would be covered during construction by the fire of forts and redoubts, direct or vertical. The zeal of the population, when appropriately directed, and when organised for the execution of well-considered plans, would cover the intervals of these works with such means of resistance as would enable us to justify the great promise that none need hesitate to make on behalf of the people of London. I am firmly and unalterably convinced of this fact, that so strong is London in its natural circumstances, rightly understood, for the special purpose of a judicious defence, that the greatest military reputation might be safely perilled on the successful defence of this capital, if only one point be conceded; namely, that we organise, be prepared, and be wise in time.

And in reviewing the history of great national crises there is an epoch which has been forcibly described by the great historian his country has so recently lost. He speaks of people resembling us nearly in their national character, like us, men of the sea, and like us, men who did not shrink from warfare on land. When the Dutch, the men of the Seven United Provinces, in their great national agony and distress, were almost overpowered by the great military monarchy of France, what was the resolution they adopted? Not to ransom their capital, in order that they might linger for a time on the marts of traffic, where whilst free they had been placed among the merchant princes of Europe; not to abandon the capital, and to betake themselves to some quiet region until the storm be overpast; but they said, "Either the country is to be held wholly and unconditionally by a free people, or it is no fit dwelling-place for them." They said, "Rather give our fields back to the salt sea, and the cities that we have wrested from the Spaniards to the monsters of the deep, than remain dishonoured in our own land." They were prepared, as the historian tells, in another clime to found new cities, and to seek new kingdoms under other constellations. But he also adds, "the men who have the courage to form these resolutions are seldom called upon to execute them." So it is with us. If we be determined, in our calm way, to declare that none shall make us afraid, and that we will hold our own, seeking to offend none, so soon as the determination is evident, and the force for defence is prepared, as has been shown full often in the history of the world, the attack is suspended, and the threatening war-cloud passes away.

POSTSCRIPT.

Since this Address has been made public, objections have been taken, both in the House of Commons and elsewhere, to the proposal for a defence of London, which it may be permitted me to examine and to test.

First. The first objection is, that if the arsenals are fortified London can be more effectually protected by armies in the field than by forts.

Secondly. The second objection results from the assumption that entrenched camps are a more certain defensive resource than fortified posts or suburban works, because an entrenched camp cannot be safely neglected by an advancing enemy.

Thirdly. That forts demand a large, clear space around them, and that works round London would be encroached upon by buildings to a dangerous extent.

Fourthly. That not only would the purchase of land for the works be very expensive, but that the connecting belt of ground required to be kept clear of buildings for future field-works would add very materially to the cost.

Fifthly. That such extensive works cannot be adequately manned, especially in artillery; and that no account has been taken of the regular army, the garrison of London.

To these objections I reply briefly—

First. That by securing the arsenals from attack, the advance of an enemy is determined through the unoccupied country interposed between the principal coast-districts of defence previously referred to. To guard against this movement the interjacent space must be occupied by an army of manœuvre. But the operations of an army of manœuvre, which has no firm base whereon to retire, will not be conducted with the requisite vigour, as was the case in 1815 with the army of the Loire.

Again, while an army of manœuvre is engaged at the front, an army corps in diversion, probably from the north-east, might threaten London, and with impunity. And an advance on the northern bank of the East Thames should not be excluded from calculation; for it must not be forgotten that, in proportion to the success that may have been obtained in the fortification of the arsenals, will be the tendency to penetrate between or turn their districts and invest the capital.

Secondly. An entrenched camp is of excellent use for concentration of troops, but if it be not placed directly in the line of approach of an invading force it does not fill the function of a fortress; and if it lies directly in that line, and thus arrests his march, the probability is, in the particular case now under consideration, that more is gained to the enemy by delay which will permit the arrival of reinforcements than even by a successful assault.

The imagination is misled and confused by an imperfect analogy between the Roman Camps and those of modern warfare.

The Roman camp exhibited the tactical disposition of a Roman manœuvring force in campaign against an enemy who possessed few mathematical or precise principles of manœuvre, excepting always the captains of the Punic wars, and of the campaigns of Magna Græcia. A modern

camp, on the contrary, represents the accidental and occasional disposition of armies of equal skill in the science of war, whereas the Roman camps were fortresses against superior weight of force; as for instance that in which Marius paused before he annihilated the Cimbri. The modern entrenched camp is but an unscientific congregation of troops, whose entrenchments are a cumbrous barrier to manœuvre, rather than a shelter against superior force.

The defeat of Braun by Frederick the Great, during his blockade of the Saxon entrenched camp at Pirna in 1756, illustrates the disadvantages of an entrenched camp of observation, and such is the design of a camp entrenched to cover London.

Thirdly. From the topographical character of London it is perfectly practicable to select positions of sufficient command to secure the works from the risk of being masked by neighbouring buildings.

In the contemplated necessity of clearing the military zone the amount of property to be sacrificed would be but trifling, and under some conditions of attack, buildings projected in advance migh tbe converted into very effective outworks.

When, also, it is remembered that the sites proposed for these works would probably be those selected by an enemy as positions for batteries, whence to harass London by vertical fire, the occupation of the ground by defensive works may appear not altogether injudicious nor too costly.

Fourthly. The purchase of land would necessarily be of considerable amount, but as respects the connecting belt of land, or zone of military communication required for the construction of intermediate field-works and batteries, the quantity purchased might be relet under suitable agreements.

For it would seem that many railway companies have displayed a largeness of design in construction, a liberality in finance, and a sagacity in selection of ground adapted to the present and future requirements of their undertaking, on a larger scale than would be needed, in order to draw a permanent rampart around London, and thus to furnish a practical object and inducement to the continuous exertions of her volunteer soldiers.

Take for instance the cost and engineering difficulties of a well-known system of railways, the central line resting at either terminal point on Liverpool and Goole. The cost of that railway was £12,000,000, and the engineering difficulties were enormous. And yet the construction of that system is not reckoned among our special triumphs of engineering science, nor the capital sunk as of much account.

Lastly, it may be difficult to maintain the zeal of the Volunteer Corps, unless some specific aim of their labours be pointed out. But if it be once made clear that they are designed for a specific duty, which no other troops can perform so well, and that on them a great responsibility will be cast, the immediate result will be not only to stimulate their efforts, but to add to their numbers. The consciousness of definite purpose will lend a most effectual impetus to the general spirit of enrolment.

I have not taken into specific account the regular forces quartered in the capital and its neighbourhood, for two reasons.

The precise strength of the Regular Army must always be a fluctuating

element of calculation, whereas the Militia and the Volunteer forces should be numbered and posted to a man.

I desire also that the Army of Reserve should be habituated to consider it to be their duty to fight in positions where local knowledge and firmness are the first requisites, and to teach them that these positions must be maintained by themselves alone.

The eleven Metropolitan Regiments of Militia and the Hon. London Artillery Corps would form an available reserve. And so much of these suggestions as is well founded is applicable to every city, town, and village of the United Kingdom.

APPENDIX.

APPENDIX A.

DETAIL OF WORKS.

Works.	Guns.	Gunners.	Infantry.	Works.	Guns.	Gunners.	Infantry.
A	20	140	200	K	20	200	300
B	20	140	200	L	20	200	300
C	25	175	250	L′	40	400	600
C′	20	140	200	M	20	140	200
D	15	105	150	N	40	280	400
D′	30	210	300	O	30	210	300
E	30	210	300	P	30	210	300
F	30	210	300	Q	20	140	200
G	80	560	700	R	50	350	500
G′	20	140	200	S	80	560	700
H	60	420	500	T	30	210	300
H′	10	70	100	U	30	210	300
I	60	420	500	W	30	210	300
I′	10	70	100	X	180	1,260	1,800

Total:—Works 28, Guns 1,050; Gunners 7,350, Infantry 10,500.
Cost at £1,000 per Gun, without Land, £1,050,000.

APPENDIX B.

ESTIMATE of PROPORTION of VOLUNTEERS available within the LONDON LINES.
Extracted from Lieut.-Colonel Kennedy's Memoir.

No. I. DIVISION—LONDON LINES.

Volunteer Force should be 4-20ths of Males capable of bearing Arms.

ALARM-POSTS.		COUNTIES AND DISTRICTS.	Total Males capable of bearing Arms.	Effective Volunteers required.
		MIDDLESEX.		
		WEST DISTRICTS.		
Holland Park	1	Kensington	30,000	6,000
Belgrave Square	2	Chelsea	14,134	2,826
Grosvenor Square	3	St. George's Hanover Square	18,307	3,661
Westminster Playground	4	Westminster	16,402	3,280
Trafalgar Square	5	St. Martin in the Fields	6,160	1,232
St. James's Square	6	St. James, Westminster	9,101	1,820
			94,105	18,819
		NORTH DISTRICTS.		
Portman Square	7	Marylebone	39,424	7,884
Haverstock Hill	8	Hampstead	2,996	599
Euston Square	9	Pancras	41,739	8,347
Cattle Market	10	Islington	23,832	4,766
Hackney Common	11	Hackney	14,607	2,921
			122,598	24,517
		CENTRAL DISTRICTS.		
Russell Square	12	St. Giles	13,533	2,710
Lincoln's Inn Fields	13	Strand	11,115	2,223
Lincoln's Inn Fields	14	Holborn	11,655	2,331
Gray's Inn Square	15	Clerkenwell	16,194	3,238
Clerkenwell Green	16	St. Luke	13,514	2,702
Finsbury Square	17	East London	11,101	2,220
Middleton Square	18	West London	7,197	1,439
Smithfield	19	London City	13,983	2,798
			98,312	19,661
		EAST DISTRICTS.		
Standard Tavern	20	Shoreditch	27,314	5,463
Bethnal Green	21	Bethnal Green	22,548	4,509
London Hospital	22	Whitechapel	19,940	3,988
Victoria Park	23	St. George-in-the-East	12,094	2,418
Stepney Green	24	Stepney	27,694	5,538
Bow Common	25	Poplar	11,790	2,358
			121,380	24,274

No. I. Division—*continued.*

ALARM-POSTS.	COUNTIES AND DISTRICTS.	Total Males capable of bearing Arms.	Effective Volunteers required.
	SURREY.		
	SOUTH DISTRICTS.		
Orchard Gardens . .	26 St. Saviour, Southwark .	8,933	1,786
,, . .	27 St. Olave, Southwark . .	4,844	968
Leather Market . .	28 Bermondsey	12,032	2,406
Lock's Fields . .	29 St. George, Southwark . .	12,956	2,591
Surrey Zoological . .	30 Newington	16,204	3,240
Kennington Oval . .	31 Lambeth	34,831	6,966
St. Anne's Hill . .	32 Wandsworth	12,691	2,538
Brunswick Square . .	33 Camberwell	13,667	2,733
Emigration Depôt . .	34 Rotherhithe	4,451	891
		120,609	24,119
	KENT.		
Greenwich Park . .	35 Greenwich	24,841	4,968
Lewisham . . .	36 Lewisham	8,709	1,741
		33,550	6,709
	Total of No. I. Division	590,554	118,099

No. II. DIVISION.—SOUTH-WESTERN LONDON LINES.

Volunteer Force should be 4-20ths of Males capable of bearing Arms.

ALARM-POSTS.	COUNTIES AND DISTRICTS.	Total Males capable of bearing Arms.	Effective Volunteers required.
	1. SURREY—exclusive of London Districts.		
Kingston . . .	47 Kingston	6,696	1,339
Richmond . . .	48 Richmond	3,976	795
	Total of No. II. Division	10,672	2,134

No. III. Division.—Northern London Lines.

Volunteer Force should be 3-20ths of Males capable of bearing Arms.

Alarm-Posts.	Counties and Districts.	Total Males capable of bearing Arms.	Effective Volunteers required.
	6. MIDDLESEX—Exclusive of London Districts.		
Brentford . . .	134 Brentford	10,331	1,548
Hendon . . .	135 Hendon	3,979	594
Barnet	136 Barnet	3,655	546
Edmonton . . .	137 Edmonton	11,324	1,698
		29,289	4,386
	7. HERTFORDSHIRE.		
Hatfield . . .	143 Hatfield	2,125	318
Watford . . .	145 Watford	4,700	705
	Total of No. III. Division	6,825	5,409

GRAND TOTAL.

No. I. Division . . .	118,099
No. II. Division . . .	2,134
No. III. Division . . .	5,409
In All . .	125,642

Friday, May 18, 1860.

Captain E. G. FISHBOURNE, R.N. C.B., in the Chair.

ON COMBINED STEAM.

By the Hon. JOHN WETHERED, Member of the American Senate.

About half a century ago, in the year 1807, after many disheartening failures which had caused nearly all of his friends to abandon him, Robert Fulton, with an indomitable spirit of perseverance, finally solved the problem that boats could be propelled by the power of steam.

Notwithstanding the establishment of the fact by the daily trips of this first successful little steamer up and down the waters of the Hudson, many years elapsed before any considerable advancement was made in steam navigation, for, even as late as 1814, seven years afterwards, there was but one steam-boat in the British empire, and she of only 69 tons' burden.

Contrast that period, within the memory of many, with what is now presented—thousands of steamers ploughing the waters of the rivers, lakes, and oceans in all parts of the world—extending the limits of commerce, developing resources, economising time, cheapening the cost of production, and consequently ameliorating the condition of mankind. Fulton did not live to see fulfilled the predictions which he had made to the President of the United States and to the Emperor Napoleon I. He died poor, because he lived before his time. The world was not prepared for a long time to see what were the clear convictions of his own mind. It affords me, however, great pleasure to say, that, when his prophecies began to be fulfilled, the American Congress, with a commendable and just liberality, voted his heirs a tract of land which secured to them a happy independence.

The subject of steam navigation in time became of so much importance that the attention of some of the most scientific and mechanical minds which the world afforded, has been directed towards improvements in the generation and application of the great motive power: boilers have been constructed with the view of bringing every particle of water, so far as practicable, into contact with the heated iron, due attention being directed to insure, if possible, a perfect circulation, so as to keep the water in contact with all parts of the heated iron. The various mechanical movements of the engine have been simplified so as to produce as little friction as possible in the moving parts of the machinery. Many suppose that the most modern-built boilers and engines are nearly perfect, and that but little remains to be done. What is called the life of a boiler lasts from five to

seven years, and, when we see boilers of the same type repeatedly replaced, both in the Government and private service, we may conclude that no very great improvements are looked for in that direction.

The great question appears to be, What is the greatest quantity of water which can be evaporated by a pound of coal? The scientific and mechanical journals are full of reports of experiments made by our Governments and by private enterprise directed to this end. In my humble opinion any considerable improvements tending to economy are not to be arrived at in that direction; most of the boilers now in use are constructed so as to produce the most violent ebullition, the result of which is, that I have found by the most exact measurement that from 25 to 40 per cent of water is carried over by, and mechanically mixed with, the steam in its passage from the surface of the water in the boiler to the cylinder of the engine. This water, which costs a considerable expenditure of fuel to increase its temperature nearly up to the point of vaporisation, produces no profit, but, on the contrary, robs the steam of its temperature, and consequently diminishes its power.

The real question to solve is, What is the greatest amount of motive power which can be developed from a pound of coal? I have proved that the former question is not the one the solving of which is of any importance, for, by my system, only two-thirds the quantity of water are used, which actually exerts more power.

The great desideratum is to obtain increased power, or economy in fuel, without the commercial disadvantage of occupying more space by the enlargement of boilers and engines, and, in war-steamers, to perform the longest voyages with the complement of coal which they are enabled to stow.

It is conceded that the Cornish boilers are the most economical, the combustion of the fuel being slow; the ebullition is not violent, but their immense size precludes their employment in steamers: I am therefore compelled to direct my attention to what we find in common use throughout the steam world afloat.

In 1858 the total tonnage of the United States was	5,050,000 tons
Of which the steam tonnage was . .	729,390 „
In 1857 the total tonnage of Great Britain was	5,520,000 „
Of which the steam tonnage was . .	671,500 „

Of this 1,400,000 tons propelled by steam-power, I venture confidently to assert, that the expenditure per indicated horse-power per hour amounts to six pounds of coal, and that fully one-third of the immense cost of running these steamers will be saved by a proper application of the system which I have recommended. There is a vast difference between employing a pure vapour, and steam saturated with water.

A volume of water requires, for its conversion into vapour, 5½ times as much heat as is sufficient to heat it from the freezing to the boiling temperature, the greater part of which is absorbed, and is inappreciable by the thermometer, it is therefore called *latent* heat by Dr. Black, in contradistinction to that measured by the thermometer, which is called

sensible heat. The heat absorbed by one volume of water amounts to 1,000° F.; this would heat 1,000 volumes of water one degree, or raise one volume of boiling water placed in a vessel where the temperature can be maintained to 1,180°. Should this vessel be suddenly opened it would be in one moment emptied by vaporization, inasmuch as the full amount of caloric equivalent to its constitution as steam, is present. (I incline to the opinion that this well-established fact applied, to the explosion of the water-casing around the chimney of the Great Eastern, might clear away some of the mystery attached to it.)

On the other hand, when steam is condensed by contact with cold substances, as much heat is lost as is sufficient to heat 5⅓ times its weight of water from 32° to 212° F., or boiling point; hence it is evident that the heat of the steam, which is in fact the power, should be maintained to the highest practicable point in the cylinder of the engine.

M. Carnot of Paris, in 1824, was the first to advance the idea that in steam machines, the labour effected, is due simply to the passage of heat through the moving power. The greater the difference of temperature of the steam before it entered the cylinder and after it left it, the more perfect were the effects produced. In this theory the dilation of bodies by the penetration of heat changes the nature of a part of the bodies, and the deficit which results therefrom is in proportion to the resistance to be overcome during the accomplishment of the dilation; the heat disappears, but a disposable labour is produced. This theory is mainly borne out by my own experience, and I have the gratification to know that it accords with that of M. Regnault, President of the Institute of France. M. Regnault filled two vessels of exactly the same capacity, which were connected by a pipe and stopcock; one he filled with steam at a pressure of 20lb., and a pressure of 228° our measure, the other being empty. He then opened the cock, when he found the pressure was reduced to 10lb., but the temperature remained the same. This result he expected, because the steam had done no work, but had merely expanded to twice its volume. He then arranged that the steam on its passage from one vessel to the other should turn a wheel to which a friction pulley was applied; the result of this experiment was, that the heat of the steam disappeared just in proportion to the amount of work done. I think, with all due deference to those who have written and experimented on the subject, that this highly interesting fact should be conclusive.

Acting on this theory, that the more heat lost in the cylinder of an engine, the more power would be exerted, and knowing by experience that a great amount of loss was sustained by the employment of saturated steam, which not only had an injurious element in the water which it contained, but also lost power by contact with every substance of less temperature than that of the steam, in the pipes which conveyed it to the cylinder, in the steam-chest, cylinder-sides, and piston-rod, &c.—this loss must necessarily occur whenever ordinary steam is employed; to obviate this loss I determined on superheating the steam, and found that it showed a small economy when surcharged to a certain degree; but, when superheated to a temperature sufficiently high to develope the full extent of the power, it destroyed the packing, and injured the slides

and cylinders. Finding, then, from considerable experience, that ordinary steam was too wet, and that superheated steam was too dry, I conceived the idea of mixing a portion of the saturated with the superheated steam, and found that it not only acted as a perfect lubrication to the rubbing parts of the machinery, but produced a power superior to that obtained from the use of either of the other steams separately.

Super-heated steam has been frequently tried, and its use abandoned as of no real commercial value, because, when all the steam from the boiler is super-heated, the temperature must vary exactly in proportion as the heat of furnaces varies; and, in cases where the required quantity of steam is most difficult to raise, the temperature of the super-heated steam must necessarily be the highest, and consequently the most dangerous.

I have no doubt there are officers in the Navy present, who know that at times it is extremely difficult to keep steam up to the desired pressure; and, of course, when that is the case, there must be less steam passing through the pipes from the boiler to the cylinder, and, as it is subjected to the same heat in the uptake, it must necessarily be greatly increased in temperature.

In carrying my system of combined steam into practical effect, I use *two* pipes in connection with the boiler, one of which conveys the ordinary steam to the cylinder, the other is connected with pipes convoluted, or arranged in any convenient form or place in the uptake, or chimney of the boiler (see Diagram), and conveyed thence by a pipe, which is joined to the first pipe at or before its entrance into the cylinder. This portion of steam through these pipes becomes super-heated to some 500° or 600° by the *waste heat* which is arrested after having passed through the boiler-tubes, and utilized in the cylinder. When the two kinds of steam inter-penetrate, the super-heated steam acts, by its excess of heat, on the watery particles of the saturated steam, expanding them some hundred-fold by converting them into vapour; whilst, at the same time, the super-heated steam is changed from a dry gas into a highly expansive vapour, *i. e.*, into pure steam, at a temperature so high as to develope the full extent of its power. By this system it is readily seen that the temperature of the steam is entirely under the control of the engineer, for by merely turning a valve he can so regulate the temperature as to produce the maximum power. A thermometer is placed in the mixed steam, as a guide to the engineer.

Some have asserted that super-heated steam will produce as much power as combined steam. I am quite sure that those who make this assertion have never given the two systems a fair trial. The experiments made by order of the three great Governments prove conclusively that the combined steam possesses every advantage over either super-heated or ordinary steam, independent of its superior economy. Those made by order of the United States Government, by the Engineer-in-Chief in person, proved that there was an economy in combined steam of 52·5 per cent. over ordinary steam, and 25 per cent. over super-heated steam. The experiments conducted by order of the Minister of Marine of France gave nearly the same results; the economy being 52·7 per cent. over ordinary, and 24 per cent. over super-heated steam. The experiments conducted by the British Government, extending through a series of

voyages, show an average economy of 32 per cent. in favour of combined steam over ordinary, when a proper application was made. The means of the power exerted by combined steam was 500 horse-power; super-heated steam, 409 horse-power; and with ordinary steam, 404 horse-power. The Lords of the Admiralty, for the purpose of giving a decisive settlement to this question, have ordered H.M.S. "Rhadamanthus" to be fitted so that either of the three kinds of steam can be used separately,—in a few weeks this highly interesting trial will be made. As an important fact bearing on this question, it was ascertained by a committee appointed by the Maryland Institute to investigate the matter, that a cistern of water was boiled at Wetheredville in one-third less time by the employment of combined steam than with super-heated steam, at the same temperature and boiler pressure.

The *rationale* of the system is, that super-heated steam partakes of the nature of gas, is a bad conductor of heat, and parts with it with difficulty; whilst the combined steam, being a pure vapour, is a good conductor of heat, and readily parts with it, which is transformed into mechanical power. In the experiments, where the heat has been measured, the combined steam always parts with more heat in the cylinders.

The indicator cards before you were taken by the Engineer officers of tho Admiralty, when experimenting on the "Dee." The inner card represents the super-heated steam,—the outer one the mixed steam. You will observe that the vacuum is much better in the latter, and that a great deal more power was exerted. The expansive force is carried out nearly to the end of the stroke. The area of the feed-valves was the same in both cases.

I have promised the Lords of the Admiralty that every steamer in the Royal Navy to which my system shall be properly applied, will be enabled to perform a voyage one-fourth further, at the same rate of speed, with the same rate of fuel; independent of which, the desired pressure can be maintained at all times, and increased at will. I need not point out this great advantage to the present assembly. Many officers know the value of an inch or two more of steam in cases of emergency, such as being on a lee-shore, or in pursuit of an enemy; or, if you can imagine such a case, pursued by an enemy,—a few pounds of steam might save the ship, or gain another.

In conclusion, I will point out some of the advantages resulting from the use of my system:—

1st. One-third of the wear and tear of boilers saved, inasmuch as only two-thirds of the quantity of fuel is required; and, as only two-thirds of the usual quantity of water are required to supply the boiler, two-thirds of the deposit are prevented.

2nd. Increased speed acquired when required.

3rd. Priming prevented.

4th. One-third of the room now occupied by coal can be used for freight; or, a vessel will perform a voyage one-fourth longer with the same quantity of fuel.

5th. A better vacuum always obtained.

6th. The desired pressure readily maintained.

7th. It is entirely safe, and under perfect control.

8th. Should any accident happen to the super-heating apparatus, by merely closing the supply valve to it at the boiler, the machinery is worked by the ordinary steam as heretofore.

THE CHAIRMAN: What is the arrangement that enabled them to obtain the Diagram before us?

Mr. WETHERED: It is very similar to the plan exhibited (see Plate, figs. 1 and 2), except that they had some of the pipes running up the chimney.

THE CHAIRMAN: That is only heated by the up-take.

Mr. WETHERED: The other was too.

THE CHAIRMAN: That would be a sufficient reason why the Diagram should be smaller. The fact of its being in the up-take is a reason why the Diagram should be of less power.

Mr. WETHERED: We find sufficient temperature in all steamers in the up-take. In the "Dee" it is between 500° and 600°; we know in some cases the heat to be as high as 750°. It is so with some of the finest steamers that run from Southampton. I may remark, that the superheating application to the "Dee" was different from the plan exhibited, some of the pipes being placed vertically up the chimney; but the Admiralty thought that would be entirely out of the question for war steamers, as they would be in danger from the shot of the enemy. Therefore I was obliged to adopt a plan of putting in two tiers of pipes entirely below the top of the boiler. There are two pipes attached to the boiler; one the ordinary pipe which carries the steam from the boiler to the cylinder, and the other arranged so as to supply the super-heating pipes.

It may be readily seen that, by the system of mixing steam, it is easy for the engineer to ascertain what temperature will produce the maximum power with safety. By merely turning the valve he has it perfectly under command, and can produce the maximum power at will. A thermometer is so placed that he can see at one moment at what temperature he is working his engine. If he finds it too high, he can turn on a little of the saturated steam, and reduce its temperature. This cannot be done when super-heated steam alone is used, because the temperature is determined by the heat of the furnace and fluctuates with it necessarily.

THE CHAIRMAN: You would still retain the general arrangement of keeping your convolute pipes in the up-take?

Mr. WETHERED: I would. There is sufficient *waste heat* in the up-take to super-heat a portion of the steam to the desired temperature for mixing. One great advantage attending this system is, that, if anything should happen to the super-heating apparatus on the voyage, all you have to do is to close the valve which supplies the steam for super-heating, and proceed with the same steam as you had before.

Mr. D. K. CLARKE: You mentioned something about the extreme heat damaging the stuffing. What temperature was that?

Mr. WETHERED: About 350° or 400°. At that temperature it will injure the packing. I have known some of the steamers that used the super-heated steam, which not only destroyed the packing, but damaged the surface of the cylinders.

Mr. D. K. CLARKE: At what temperature is your combined steam?

Mr. WETHERED: About 350°.

Mr. D. K. CLARKE: That is nearly the same.

Mr. WETHERED: Yes, but mine is lubricating steam.

Mr. D. K. CLARKE: Then you do not think it would be so hurtful?

Mr. WETHERED: Oh, no. I can work combined steam at a higher temperature than super-heated steam, which is entirely dry. The "Dee" has had the combined steam in operation for two or three years, and has not had the slightest difficulty, the temperature being sometimes 350°. The "Black Eagle" Admiralty yacht has had it a long time, and she makes a considerable economy of fuel and increase of power. It has been applied to the Royal Mail steamer "Avon," and she has run about 160,000 miles, and has not had the slightest difficulty with it, except on one occasion in the tropics, when the engineer heard a slight screaming at the slides. He immediately turned on a little more saturated steam, and he has had no further difficulty. Since I came to England I find that several parties have been trying to pirate from me, by employing simply super-heated steam. The Royal Mail Company, after having tried their several different plans, have placed one of the finest of their steamers at my disposal for a proper application of my system, and stated in their last report, that, if successful, it would be applied to all the steamers on their line.

THE CHAIRMAN: In drawing a distinction between common steam and super-heated steam, you said one was a mere vapour, and the other a gas. Do you mean to say a chemical action takes place; that one is merely a mechanical separation of the particles of water, and the other a chemical separation?

Mr. WETHERED: I think so; you could not call it a hydrogen gas, but it approximates to it.

THE CHAIRMAN: Is there any electricity given off?

Mr. WETHERED: I have thought there was electricity evolved when the two kinds of steam came in contact. On one occasion I heard a noise, as if ten thousand little tacks were dancing along the inside of the pipe, and I judged it to be caused by electricity.

Mr. D. K. CLARK: I think it is of some importance to know whether there is any essential difference between combined steam and super-heated steam at the same temperature. As the pressure and density are practically the same whether you use super-heated or combined steam, taking the same temperature, I am at a loss to know what the essential difference is.

Mr. WETHERED: There have been theories started for the purpose of explaining the superiority of mixed steam over super-heated steam, even at the same temperature. Professor Regnault, who has had as much experience in steam as any of us, says, as a general remark, that he could not see why super-heated steam at the same temperature would not perform as much work as combined steam. The Abbé Moigno, Editor of the Cosmos, said, it is not the fact, as he had watched it for whole days, and had observed that, as soon as ever the steam was mixed, the engine has exerted a power of 24 per cent. more than when steam simply super-heated was employed.

Mr. D. K. CLARKE: You mean, as they mix super-heated steam with common steam.

Mr. WETHERED: Yes.

Mr. D. K. CLARKE: No doubt the engine runs off because the steam is drier.

Mr. WETHERED: No; when they are using super-heated steam, and they mix it, the engine will increase its revolutions. The steam then is not so dry, but elastic. It might be that super-heated steam is like so much hot air when it is cooked too much, there is not the moisture and elasticity in it that a pure vapour contains. The reason I have given is the same as that given by Professor Regnault, that the one partakes of the nature of gas, is a bad conductor of heat, and does not part with it readily; whilst the other, being pure vapour, is a good conductor of heat and parts with it readily, and consequently exerts more power.

Mr. D. K. CLARKE: I do not know that Regnault has made experiments on super-heated steam. He has made experiments on saturated steam.

Mr. WETHERED: The learned Abbé Moigno, the associate of the illustrious Arago in his interesting scientific discoveries, witnessed the experiments made by the French Government with super-heated and combined steam, and submitted the detailed results to M. Regnault, who, upon investigation, gave the *rationale* which I have just communicated, and with which I entirely concur, as I have always found it the case that more heat is utilized when the mixed steam is used than when either super-heated or ordinary steam is used; and there is strong confirmatory evidence in support of the theory in the report of the committee of the Maryland Institute on boiling water with the three kinds of steam.

The HON. CAPTAIN DENMAN: May I ask to what temperature you heat super-heated steam when it leaves the boiler, in order to get 350° at the cylinder?

Mr. WETHERED: From 500° to 600°. It varies between these figures according to the draught of the boilers..

The HON. CAPTAIN DENMAN: May I ask also the size of the super-heated steam-pipe and the ordinary pipe?

Mr. WETHERED: The ordinary pipe of the "Rhadamanthus" is about ten inches; the super-heated steam-pipe is only five inches. With the super-heated steam I always leave the valve wide open, because it is subjected to greater friction than it would be with the ordinary steam.

The HON. CAPTAIN DENMAN: You keep the temperature at 350°?

Mr. WETHERED: We can use it considerably above that point with safety. But with super-heated steam at that temperature the slides have been damaged.

The HON. CAPTAIN DENMAN: Has it been found that super-heated steam unmixed, at 350° damages the slides?

Mr. WETHERED: Yes, and the surface of the cylinder also. A number have been damaged. A short time ago some experiments were made on the steamers that run from Panama down the west coast of South America. The consumption was reduced very low, and it was startling to see the enormous economy stated to have been made. They super-heated the steam as part of their plan, and used surface condensers, and a number of good things. Not more than three weeks ago I received a letter stating that the super-heated steam apparatus had all been taken out, as it damaged the slides and cylinders.

The HON. CAPTAIN DENMAN: You think it is a great advantage to lower the temperature by mixing?

ARRANGEMENT OF PIPES FOR APPLYING WETHERED'S SYSTEM OF COMBINED STEAM.

Fig. 1.

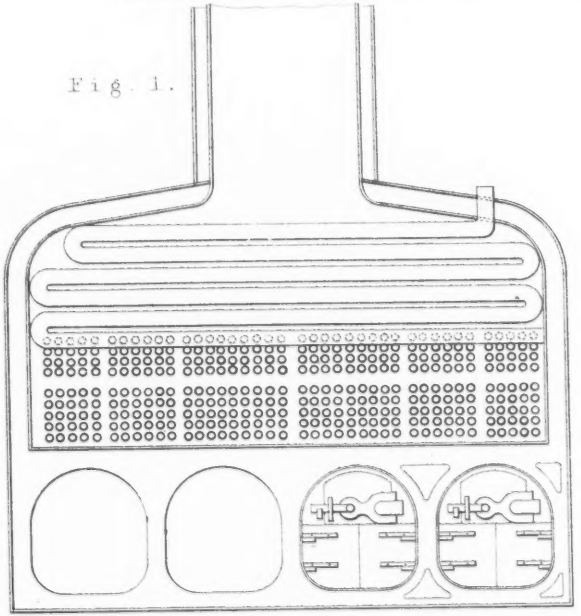
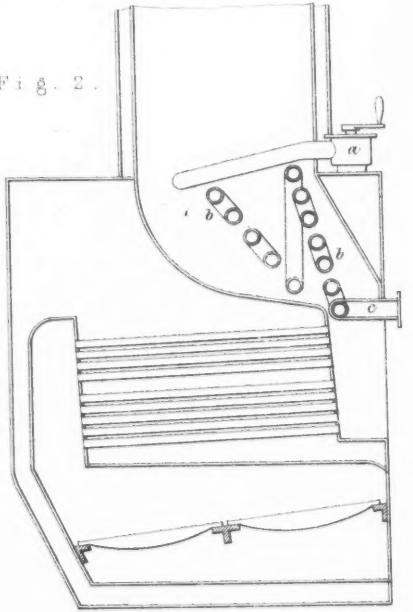


Fig. 2.



Mr. WETHERED: It is a great advantage, independent of the complete control which it gives the engineer over it.

The HON. CAPTAIN DENMAN: You know of no other means of doing it?

Mr. WETHERED: I do not know of any. I may add, that the question to which the gentlemen referred, with regard to the value of the two kinds of steam, will soon be decided by the Lords of the Admiralty. They are fitting the "Rhadamanthus" up for the very purpose of setting that matter at rest. I am perfectly willing to leave it in their hands. And I avail myself of this occasion to tender my acknowledgments for the uniform kindness and courtesy which I have received by all in connection with the Admiralty and Navy with whom I have been brought into contact.

THE CHAIRMAN: Mr. Wethered has been kind enough to introduce to us a very important and interesting subject. He has put it in a very simple and intelligible way. Of course, one cannot, without being present at the experiment, venture to pronounce entirely in favour of it; but, certainly, so far as the system has been explained, it possesses a decided advantage. I can quite understand the economy; it is quite palpable to anybody who understands it. It is clear that if a convolute is placed in the up-take to retain the heat, which is often found going to waste through the top of the funnel, it would be a great economy. We are all very thankful to Mr. Wethered. His report is the more interesting, in that he is an ex-senator of the United States, and has come to lecture in the Royal United Service Institution of Great Britain. I trust it is an omen that the two countries will continue joined together in a rivalry for the advancement of the arts and sciences.

DESCRIPTION OF THE PLATE.

Figs. 1 and 2 are longitudinal and transverse sections of an ordinary tubular boiler, showing the pipes for super-heating the steam in the uptake.

a. Stop-valve, by which steam is admitted from the boiler to the pipes *bb*, by which it is super-heated, and from thence it is carried away to the cylinder by the pipe *c*, *where it is mixed with the ordinary steam*.

This arrangement of super-heating pipes can be readily applied to existing boilers. A stop-valve is fitted on the boiler, for admitting the steam into these pipes, which is heated to a temperature of 500° or 600°, and then carried to the cylinder, where it is mixed with the ordinary steam direct from the boiler, by which process a saving of fuel is effected of from 25 to 33 per cent., as well as a considerable increase of power given, as shown by the reports of the Admiralty of the application to H. M. Ship "Dee."

The Royal Mail Steam Packet Company's Ship "Avon" has made voyages to the Brazils and back, amounting to 160,000 miles, with this system of combined steam, with the most perfect success.

It is thus shown that vessels capable of carrying by the present system only 32 days' consumption of coal, can, by adopting Wethered's system of combined steam, maintain the same speed with the same quantity for 40 days, a desideratum so highly important that it needs no comment here.

The foregoing explanation applies to marine boilers, but this system of combined steam is equally applicable to all steam power.

Evening Meeting.

March 19th, 1860.

Captain E. G. FISHBOURNE, R.N., C.B. in the Chair.

NAMES of MEMBERS who have joined the INSTITUTION since Feb. 20th.

LIFE.

Hand, Geo. Wightman, Mid. R.N.
Tytler, W. F., Capt. 9th Beng. Lt. Cav.

ANNUAL.

Barnes, C. H., Lieut. H.M. Beng. H. A.
Wickham, E. H., Lieut. R.A.
De Salis, Rodolph, Col. 8th Huss.
Reilly, W. E. M., Major R.A. C.B.
Philips, N. G., Capt. Hon. Corps Gent.-at-Arms
Carter, J. M., Capt. Monmouth Mil.
Croft, C. P., Surg. Victoria Rifles
Greathed, E. H., Col. unatt. C.B.
Birch, Thomas F., Capt. R.N.
Luard, John, Maj.-Gen. Mad. Army
Colomb, P. H., Lieut. R.N.
Stephenson, H. J., Capt. late 18th Royal Irish, 1st Surrey Rifle Volunteers
Dent, Edward, Com. R.N.
Sturdy, J. B. S., Capt. 5th Lancashire Volunteers
Cooper, R. A., Capt. Sco. Fus. Gds.

PRESENTS.

LIBRARY.

Books.

Philosophical and Literary Society of Leeds.—Sensorial Vision: a Paper read by Sir J. F. W. Herschel, Bart., K.H., F.R.S., before the Society, 30th September, 1858. Pam. 8vo. Leeds, 1858.

China and its Trade: a Paper read by J. Crawfurd, Esq. F.R.S., before the Society, 17th November, 1858. Pam. 8vo. London, 1858. *Presented by the Society.*

Yonge, W. L., Captain, Dep. Asst. Adj. General, R.A.—Notes on the Early History of the Royal Artillery. Part I. Pam. 8vo. Woolwich, 1859.
Presented by the Author.

Marcy, Colonel Commanding 1st Regiment of Cuirassiers.—Memoir on Swords, &c. Translated from the French by Captain and Lieut.-Colonel Henry Hamilton Maxwell, H.M. Bengal Artillery. Small 8vo. London, 1860. *Presented by Mr. John Weale.*

Zoological Society of London.—Proceedings of the Society. Part III., June. Dec. 1859. *Presented by the Society.*

Rules and Regulations for Her Majesty's Colonial Service. 1 vol. 8vo. London, 1856. *Presented by W. F. Higgins, Esq.*

Lecture on the Geology of the Province of Nelson. Extract from the New Zealand Government Gazette of the 6th December, 1859.
Presented by W. Gisborne, Esq., Under Colonial Secretary, New Zealand.

Hewitt, John, Esq., Mem. Archæ. Inst. Gt. Britain.—Official Catalogue of the Tower Armouries. 1 vol. Small 8vo. London, 1859.
Presented by the Secretary of State for War.

Royal Geographical Society.—Proceedings of. Vol. IV. No. 1. 1860.
Presented by the Society.

Adye, John, Lt.-Col. R.A., C.B.—Review of the Crimean War to the Winter of 1854-5. 1 vol. 8vo. *Presented by the Author.*

Nares, George S., Lieut. R.N.—The Naval Cadet's Guide. 1 vol. 8vo. London, 1860. *Presented by the Author.*

Lyon's Voyage to Repulse Bay. 1 vol. 8vo. London, 1825
Presented by John Barrow, Esq., F.R.S.

Maps, Charts, &c.

Map of North Holland, given to Prince William, at the Helder, on 29th Oct. 1799, by Col. Kragenheim, Chef d'Etat Major to the Dutch Army during the War in Holland in 1799. *Presented by W. F. Higgins, Esq.*

MUSEUM.

Military.

Bow. 2 Iron-headed Spears. 3 Wooden Javelins from the Island of Palawan.
Presented by Captain E. Gardiner Fishbourne, R.N., C.B.

Musket recovered in 1859 from the wreck of La Latine, frigate 32 guns, Captain Launcelot Skymer, which frigate sailed from Yarmouth Roads for Hamburgh on the morning of 9th October, 1799. She was lost in a heavy gale the same night on the outer bank of the Island of Vlieland, and, with the exception of one man, every soul perished.
Presented by Captain George Halsted, R.N., in name of the Committee for managing the affairs of Lloyd's.

Battle Axe brought down from the Great Lake, discovered by Dr. Livingstone.
Presented by Mr. W. G. Rawbone.

Miscellaneous.

Russian Water Bottle or Canteen from Sevastopol.
Presented by Mr. E. Kiddle, War Office.

Specimens illustrating the Manufacture of Gun Flints.
Presented by the Royal Institution of Great Britain.

Part of a Flag of H.M. Ship Victory, carried in procession at Lord Nelson's funeral, which it was intended should have been lowered into his vault, but was torn up and appropriated by the sailors who carried it. *Presented by Captain W. H. Dobbie, R.N.*

1 Medal, Danube (silver). *Presented by the Lords Commissioners of the Admiralty.*

NEW SYSTEM OF COOKING FOR THE ARMY.

By Captain J. Grant, *late* R.A.

I have been requested to offer you some explanation of this new system of cooking for troops which I have lately introduced into the Service, and, although it is a homely subject for a Lecture, it is one which is deserving of more attention than it has hitherto received.

We know what all the armies suffered from bad food during the Crimean war; and, although the British soldier is better supplied than any other soldier in Europe, he is by no means the best fed—simply from defective cooking.

This induced me to turn my attention to the subject with the view of providing a remedy for this great defect in our system, and placing within the soldier's reach some simple mode of cooking his food agreeable to his taste, instead of being confined to his every day "soup and *boulli*." We do not want Soyer cooks for, teaching our soldiers, for, although the majority of them are bad cooks, there are good ones enough to teach the rest, under intelligent non-commissioned officers,—and the sooner

this is reduced to a system the better, for a School of Cookery is quite as essential as a School of Musketry. It is no use having rifled guns and muskets without good men to work them; and we cannot have good men without good food.

The models on the table represent the three different modes of cooking which I propose for the soldier's use, in barracks, in the field, and on the march. This model, which is on the $\frac{1}{8}$ scale, represents the mode of cooking in barracks, which enables the soldier to *bake*, *boil*, *steam*, or *fry* his food, in any way agreeable to his taste.

In this apparatus (see Plate I. fig. 3) you will observe there are two small fires on a level with the floor line,—the ash-pits being taken out of the ground, which gives the men a good command over the cooking vessels,—these two fires are connected by a brick flue, covered with iron plates, to receive the cooking vessels; both flues terminate in one chimney, in which an oven is placed, heated by the products of the two fires in its passage up the chimney, and is capable of baking 400 rations of meat.* Each of the twelve kettles will steam or boil meat and soup for 50 men, and the vegetables are steamed over the kettles: thus the rations of 1000 men may be cooked in this apparatus, although it is constructed for only 500. The hot plate also affords the means of frying or stewing any small messes that may be required; and I consider a hot plate for a soldier's permanent kitchen a great acquisition.

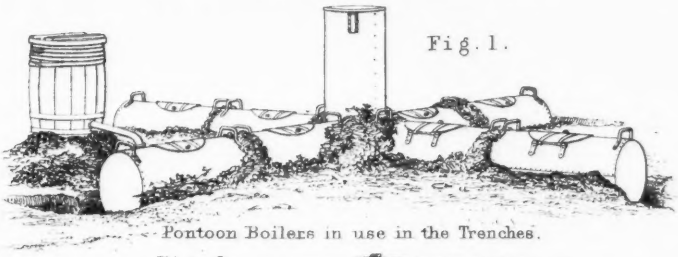
It is supposed by some persons that this mode of cooking in barracks is only applicable to a large number of men—but this is erroneous; for, although none of the apparatus which has hitherto been constructed has been for less than 500 men, the principle is as applicable to a hundred as it is to a thousand. You will observe that the construction of this oven is somewhat different from the generality of iron ovens, which give a peculiarly strong taste to the meat; but by this mode of heating such a high temperature can be raised, that I can afford to have a current of air constantly passing through it, by means of these ventilators, so that the meat becomes more like roast than baked.

At Aldershott all the cook-houses are fitted, by order of the Government, for the requirements of 1000 men, with kettles containing 20 gallons; but I ventured to recommend that apparatus for 500, at a cost of about 80*l.*, with 12-gallon kettles, would be more convenient. This was approved of, and all that have since been constructed upon this principle have been for this number, and I have heard of no complaints. I ought to add that the work at Aldershott was badly carried out, and that this principle of cooking must not be judged of by the manner in which it is conducted in that encampment; although some allowance must be made, as this was the station where it was first introduced in April, 1855.

* The 400 rations of meat are baked with the *waste* heat which is generally thrown off by the chimneys, and there is no difficulty in applying this principle of baking to all our ships of war. A portion only of that heat which is now wasted in all the smoke flues and cooking galleys throughout the navy, would, if properly applied, suffice to bake bread enough for the whole fleet; and an occasional change of soft bread for the every day biscuit would be appreciated by our sailors, and much valuable stowage space gained in the bread rooms, besides effecting a large pecuniary saving to the country by the purchase of flour for our ship's crews when on foreign stations.—J. G.

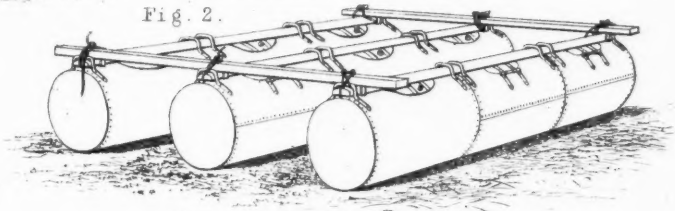
CAPTN GRANTS COOKING APPARATUS

Fig. 1.



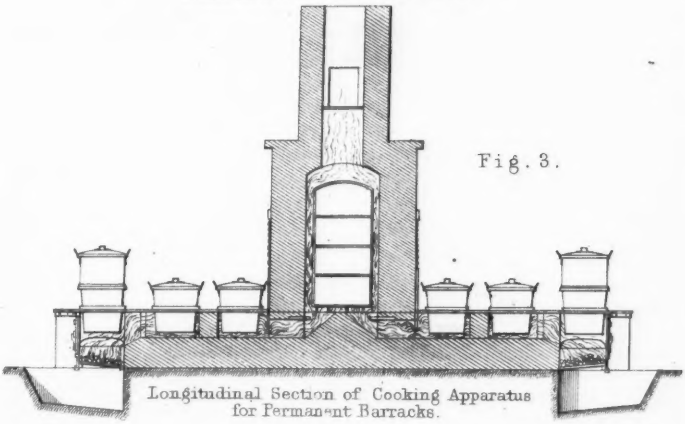
Pontoon Boilers in use in the Trenches.

Fig. 2.



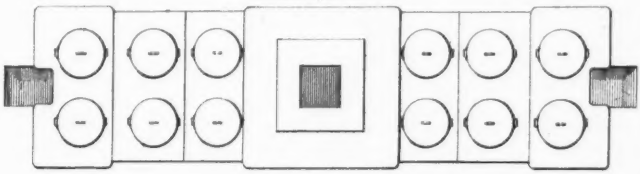
Pontoon Boilers fitted as a Raft.

Fig. 3.



Longitudinal Section of Cooking Apparatus for Permanent Barracks.

Fig. 4.



Plan

0 1 2 3 4 5 10 FEET

J.R.Jobbins.

I will now explain the mode of cooking in the field:—

I call these cooking vessels, which are made of plate iron galvanized, "Pontoon Kettles," (see Plate I. fig. 1), because from their peculiar form they answer the purpose of pontoons as well as cooking kettles: they are packed for travelling in one of the ordinary artillery waggons (Plate II. fig. 2), fitted for the purpose, and furnished with all necessary fitments, such as spades, pickaxes, cross-cut saws, hand-saws, axes, &c., for cutting trenches, and felling trees for fuel. The waggons are drawn by a pair of horses when the vessels are empty, and by four horses when filled with provisions. When the troops arrive on their encamping ground, they select as level a spot as they can, and commence cutting the trenches in the shape of a cross, and at the intersection a small chimney, three feet high, is placed, resting on the ends of the kettles which occupy the trenches, two kettles being placed on each arm of the cross (see Plate I. fig. 1). Fires are then lighted at each end of the four trenches, and in about two hours-and-a-half the dinners for 800 men can be well cooked. During the two last summers, two batteries of artillery cooked in this way at Woolwich.

The dishes are provided for cutting up the messes, which also answer the purpose of frying-pans; and when the soup and meat is ready to serve, the frying-pans are put in requisition. Means are also provided for steaming either meat or vegetables, for wherever there is artillery there must be empty powder barrels, in which the steaming is carried on, by the aid of a short piece of gas-pipe, to conduct the steam from the cooking kettles into the barrels. These kettles may be worked from a single kettle up to the full number of eight, either in one line of trench or in the form of a cross; and a turf chimney will answer as well as an iron one; and the cooking may be carried on in any kind of weather. Another advantage is the facility of transport; for the kettles can be easily slung on the backs of horses or mules, and from their cylindrical form will bear the rough usage to which they are necessarily exposed. Each kettle is three feet long and fifteen inches in diameter, containing twenty-five gallons, and weighing sixty-two pounds. There is also a provision for roasting a sufficient quantity of coffee for a thousand men over the chimney, and grinding it at a gun-wheel during the time occupied in cooking the dinners, and the coffee roaster packs inside the chimney when travelling.

I will now shew the mode of forming a raft by the aid of these kettles, (Plate I. fig. 2), and with two sets of them I would undertake to transport a battery of 12-pounders across the Thames. I do not know whether any person present witnessed the trial of these kettles in Hyde Park, during the last summer, but His Royal Highness the Duke of Cambridge attended with much interest, and said: "I understand all about your cooking, but I want to see how you manage to get troops across a river." So after the dinners were all served the kettles were removed from the trenches (which were cut near the Serpentine), and in about five minutes two rafts were formed. Four guardsmen manned one, and four artillerymen the other, and they crossed and re-crossed the Serpentine with perfect ease and safety, to the amusement of all who witnessed the trial. A river may easily be bridged

by the aid of these kettles for a regiment to cross in double file, and the cooking kettles of half-a-dozen regiments will suffice to bridge a good sized river.

I will now explain the mode of cooking while troops are on the march:—

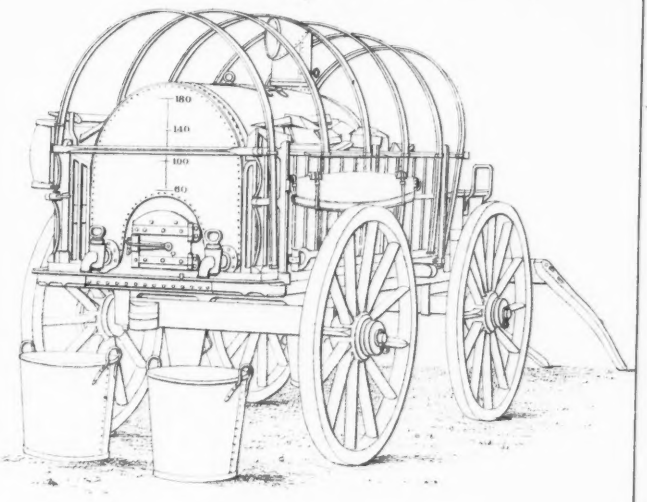
With this single cooking vessel, which I call an "ambulating boiler," (see Plate II. fig. 1), dinners may be well cooked for 800 men in 2½ hours, the horses walking or trotting. This is also made of galvanized plate iron, but rather thicker than the pontoon kettles. It is somewhat peculiar in construction, in order to obtain a large amount of heating surface. It is fitted on one of the ordinary artillery waggons, and furnished with all the same kind of fittings and tools supplied to the pontoon waggon. The boiler contains 180 gallons and is graduated on the outside, so that, whatever may be the number of men to be cooked for, the cook has only to refer to the figures which are marked outside the boiler, and the number of gallons of water required is at once ascertained. The meat and potatoes are boiled in nets, and that which is intended for soup is cut small and put into the boiler first. The motion of the waggon while travelling keeps this in constant agitation and prevents the necessity of stirring. When it is ready to serve out, the nets which contain the meat and potatoes are hooked out of the boiler at a door at the top, and the soup is drawn off by means of two large taps into two soup kettles provided for this purpose, and from which the men receive it. I have seen the dinners of 500 men served from a boiler of this description in a quarter of an hour. There is also a great saving in the consumption of fuel, for it requires only *one-eighth* part of the present Government allowance, which is 3 pounds of wood per man a day for field service. This admits of two days' fuel for 800 men being carried in the same waggon, which answers the double purpose of cloathing the boiler and assisting to dry the wood if green or wet. The waggon may be drawn by a pair of horses when the boiler is empty, for it weighs only 6½ cwt., but when filled four horses are necessary. I have seen one of these boilers trotted down Shooter's Hill, full of soup, and on its arrival at Dartford Heath dinners for 600 men were served out.

In introducing these modes of cooking for the army, I wish it to be understood that I do not propose to deprive the soldier of the means of cooking his own rations, under any circumstances, on the contrary, I think it so important that he should be independent of all aid that I have designed a little mess tin, which will enable him to cook his ration with a pound of vegetables in half-an-hour with proper management ; but I consider it equally important to furnish the means of transport for cooking vessels when troops are acting in large bodies, and it is only those who know the practical difficulties of soldiers carrying our lumbering camp kettles on a march, who can understand the importance of providing transport for cooking vessels. This is, however, becoming better understood, for I have been requested to direct the construction of sufficient field cooking apparatus for 5,000 men destined for service in China. This I have seen completed and shipped.

The cooking apparatus for barracks was first introduced in the Hut Barracks at Aldershott, in April, 1855, in consequence of the then mode of cooking with iron stoves being found so inefficient that it became necessary

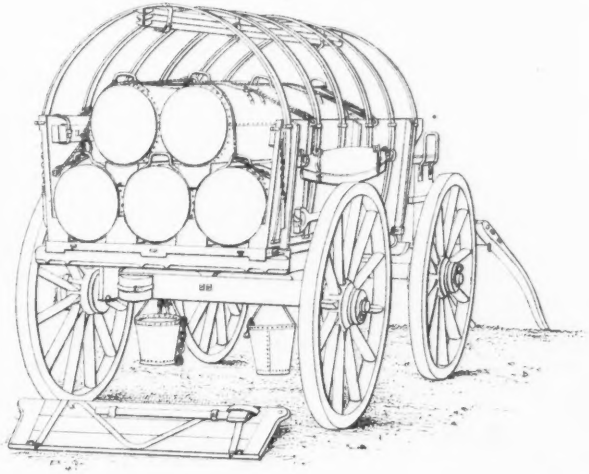
CAPTN GRANTS COOKING APPARATUS.

Fig. 1.



End View of Ambulatory Boiler Wagon.

Fig. 2.



End View of Pontoon Boiler Wagon.

J.R.Jobbins.

to remove them. Since that period the whole of that encampment has continued to cook upon this new plan, although the construction of the work was badly carried out under our contract system, for the brickwork was very defective.

This mode of cooking has since been extended to the Curragh and Shorncliffe camps, and some garrison towns, and, although much better carried out than at Aldershott, there is still room for improvement in the brickwork, which requires to be of the very best description.*

I must here repeat that cooking for an army is a matter of much greater importance than has hitherto been attached to it.

When I first turned my attention to the improvement of our system, the different modes of cooking throughout the service (from iron coal stoves to gas) were as varied as the cost, which ranged from *five farthings* to *five pence* per man per week for fuel to cook three meals daily. For example: at St. George's Barracks in London, where the soldiers had been cooking with gas for some years, the barrack master's fuel return for December, 1858, will shew that it amounted to *five pence* per man per week for cooking purposes alone, whereas upon this system of cooking it only amounts to *one halfpenny* per man per week, and I am prepared to prove that the principle admits of its being reduced to less than *one farthing*.

These results were obtained after much labour and expense, and if the authorities whose duty it may be to provide proper cooking accommodation for our troops had expressed any desire to confer with me upon the subject, a good and uniform system of cooking, which is much wanted, might have been established throughout the Service long since.

I regret to add, that during the prosecution of this work I have experienced something more than the ordinary difficulties which always attend the introduction of everything that is new, for I have had to contend with much opposition ; but the admission of improvements for the benefit of the public service should not be made dependent upon their emanating from an official source.

In conclusion, I beg to state that I have devoted many years to the consideration of cooking and baking bread for our army :—for, strange to say, the English army is the only one in Europe which does not bake its own bread, and I can now state with perfect confidence, that if this system was properly carried out, and the soldiers instructed as they ought to be in cooking and baking, that better food of every kind would be secured to the soldier, and a very large pecuniary saving secured to the country.

The CHAIRMAN: I am sure that this Meeting feels much indebted to

* This mode of cooking and baking bread has been in operation at the London Reformatory, 237, Euston Road, for the last three years ; but the principle has been better carried out at the New Schoolhouse at Southall, than at any military station I have seen. Provision is there made for the cooking and baking bread for 500 children, besides supplying hot water for baths and washing the linen of the whole establishment. This schoolhouse has lately been erected, at a cost of £16,000, for the education of the pauper children of the Marylebone Union, and is situated close to the Southall Railway Station on the Great Western line, about ten miles from London. The establishment is well worth visiting.—J. G.

Captain Grant for the interesting and valuable information which he has given us upon this important subject. Captain Grant has not only introduced a good system of barrack cooking in every variety, but he has designed an equally efficient mode of cooking for an army on the march and in the field.

NOTE.—On referring to the Official Report, printed by order of the House of Commons, and laid before Parliament the 8th of June, 1858, headed "Captain Grant's Kitchens," it is stated that Captain Grant's system of cooking is not only very superior to the old boiler system, but it effects a saving in the garrison of Woolwich of $297\frac{17}{20}$ tons of coal per annum upon every thousand men.—J. G.

LOYSEL'S PROCESS FOR MAKING TEA AND COFFEE IN LARGE QUANTITIES FOR TROOPS.

By MR. E. LOYSEL, Assoc. Inst. C.E.

THE introduction of these machines into the British army was suggested to me by Captain Fowke in the year 1855, when Secretary of the British Commission at the Paris Exhibition, where these machines were exhibited, and were at work for five months. All the coffee and tea that was consumed during the Exhibition was manufactured by them. They attracted the attention of his Majesty the Emperor, and, in consequence, I had the honour of offering him the first cup that was made (in a large machine on this principle by steam power) at the Paris Exhibition. It was naturally brought under the notice of the French Secretary at War, Marshal Vaillant, and a commission was named to examine the invention. Their report was satisfactory, experiments were made in the army, and were highly successful, and a large machine was erected in 1855, and is still at work at the *Val de Grace*, the largest military hospital in France, where all sorts of infusions are produced daily. Captain Fowke, having seen the machine at Paris, naturally thought that it might be usefully adapted to the wants of the British Army, and he had the kindness to give me an introduction to Captain Siborne, the Commander of the Royal Engineer Train at Aldershott. Captain Siborne received me with great kindness and courtesy, and gave me all the information I wanted respecting the habits of the British Army. I accordingly had machines for eighty men made at Birmingham, and they have given satisfaction. Captain Siborne, who examined the working of the machine with great care, pointed out various modifications, which I have adopted, to increase the efficiency of the machine, and the machine which I am going to explain to you is constructed from the suggestion of Captain Siborne. It has been in use six months at Aldershott and Chatham, coffee and tea being prepared alternately morning and evening in the same machine. The men report that the machine imparts no unpleasant taste whatever; it has merely to be thoroughly well rinsed after each operation. This fact illustrates practically how easy to cleanse the machine is; and, after six months' use in camp, and in the field, the machine in question is as sound and clean as the first day. Now, if you will allow me, I will read the following Report, which will state better than I can what the apparatus will accomplish.

Copy of a Report by Captain H. S. Siborne, R. E. upon Loysel's Patent Hydrostatic Tea and Coffee Machine, used by the Royal Engineer Train.

SIR, Aldershott, 18 Nov. 1856.

I have the honour to submit for the information of the Lieutenant-General commanding the division, the following report on the "Hydrostatic Tea and Coffee Ma-

chine," which I recently took to him for his personal inspection. The machine he saw contained 12 gallons; and, as there appears to be an objection to its size, I have since ascertained from the patentee, Mr. E. Loysel, C.E., the price of a 6-gallon machine, and I presume the prices of others of different sizes would be in proportion.

The 12-gallon machine, which can supply tea or coffee for 100 men, costs 10*l.*, whether for a single one or a number of them; that of 6 gallons, suitable to 50 men, would cost 5*l.* 10*s.*

They can be used, however, for only two or three men if necessary, and are consequently extremely well suited to hospitals. I have sent one of them to the Purveyor of the Hospital at this Station, who speaks very highly of it, and is endeavouring to get them generally introduced into the service of the hospitals.

The great merits of the invention are—

1st. The simplicity and celerity with which the tea or coffee can be made for a large number of men.

2nd. The certainty of the essence of the material being entirely extracted from it for the use of the consumer.

3rd. The saving in expense of material which is effected.

The A troop, R.E. train, has now used them for upwards of three months, and we find that the men's meals can be instantaneously provided at any moment. The tea or coffee is as pure as can possibly be produced from the leaves or berries, both being previously ground. Sugar being added before applying the water, its essence is so much better extracted than in the ordinary manner as to necessitate a much smaller quantity of it.

The saving effected to the men's messing amounted (previously to groceries being issued by the Commissariat) to no less than 18 per cent. the only requisites are that both the tea and coffee should be ground, and a quantity of boiling water added equal to the amount of liquor required.

The proportions were an ounce of either tea or coffee to every six men, and a pound of sugar to every eight. These proportions were used in making tea or coffee for an average of 80 men; for very small numbers, perhaps, more material would be requisite.

We used the machines on the occasion of throwing up field-works before Her Majesty in August last with perfect facility, merely boiling the water in the camp kettles; if these had not been at hand the men's canteens might have answered the same purpose.

I drank some of the tea, and found it excellent. From the experience we have had, I am convinced that their introduction into the service would be of the greatest benefit to the soldier, as he would, under all circumstances, when able to secure a supply of hot water, be instantaneously provided with good wholesome liquor, in fact the reverse of what he now sometimes receives, particularly on service. He would save money by means of them when he finds his own groceries, and the public when it supplies them to him.

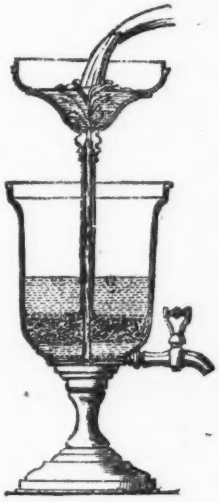
The one I submitted to the Lieutenant-General was fitted so as to be perfectly portable on service either in a waggon or on a packhorse. For the experience we have had of them, I think their introduction into the service would be of the greatest possible benefit both to the soldier and to the public; and I also beg to bring to your notice the extreme willingness of the patentee to meet any suggestions for improvement, or to make such reduction in the price as not to deprive him of a due remuneration.

(Signed) H. S. SIBORNE,
Capt. Com. R.E. Train.

I will now explain the operation.

The material to be operated on is placed between two or more finely-pierced plates or diaphragms, the lower one being a little distance from the bottom of the containing vessel, and through which a small pipe passes so as to deliver the fluid (poured in a reservoir at the upper orifice) below it. The infusing liquid is then introduced from the upper reservoir, and, displacing the air, forces its way upwards by the pressure of the column (or hydrostatic pressure) through the substance under operation, (every particle of which is saturated in its passage,) and accumulates above the upper plate. When a sufficient quantity has been thus forced upwards, by opening a tap the whole is drawn off, percolating

again downwards by its own specific gravity through the material, which now acts as a filtering bed, and the infusion is obtained prefectly clear, and containing all the aromatic and useful principles of the substance.



In tea-making, the whole of the soluble and aromatic principles are rapidly and completely extracted, and thus one homogeneous infusion of excellent quality is at once obtained instead of the two or three continually diluted ones which attend the ordinary routine. I am able also, by this apparatus, greatly to increase this effect by previously triturating, crushing, or grinding the tea, and thus exposing a very largely extended surface to the action of the boiling water—an operation which is incompatible with the ordinary teapot.

In constructing these apparatus, the dimensions must vary according to the quantity to be treated in them. If I construct a large apparatus, and put in a large quantity of coffee, it will be impossible to expel all the air in the mass of substance by hydrostatic pressure, and percolation cannot take place. To overcome this obstruction, I divide the substance into layers, by using a greater number of perforated diaphragms or filters, and putting one-half or one-third, or a smaller quantity, of ground substance between them as circumstances may require. But here an obstruction occurs, owing to the volume of air there is between the separate layers of substance, and this is got rid of by putting in a vertical tube, perforated so that the air passes off. In Paris I have constructed machines in which they put some 60lb of coffee, and in a quarter of an hour the process of infusion and extraction is completed. These machines have as many as eight chambers; and, by multiplying the chambers and providing for the exit of the air, there is no limit to the size of the machine. It can be applied on any scale for any vegetable substance, in fact it can be applied to brewing, for extracts of dye-wood, and for all sorts of medical extracts. The apparatus may be made of various materials, and in various shapes, to suit the pocket and the taste of the buyer; and, to provide against the infusion getting cold, the machine can be supplied with an enamelled chamber, into which the liquid passes, and there it can be kept hot by the use of a little lamp, or of gas, lighted underneath.

Mr. Loysel next explained the properties of tea and coffee, and discussed their relative merits; and as the result gave the preference to coffee as a beverage to soldiers, both on the ground of economy and health. The soldier in the field, he said, would support fatigue a great deal better, and the quantity of food he would require would be a great deal less. It was found by a practical experiment that the saving would be no less than 25 or 30 per cent.

The CHAIRMAN.—What is the proportion of coffee you ordinarily give?

MR. LOYSEL.—Scientific authorities in France recommend an ounce and a half to a pint, but that makes a very strong coffee. In this country I recommend one ounce to the pint.

The CHAIRMAN.—You recommend that the tea should be triturated, or bruised. Why do you bruise the tea?

MR. LOYSEL.—Because I extract more of the properties of the tea, and the infusion is instantaneous. It is an error to think that by triturating the tea it will extract too much, and give a woody taste. In tea there is nothing obnoxious except the tannin, which is extracted only by boiling or by prolonged infusion, whilst in the hydrostatic percolator the extract is obtained instantaneously, and by mere infusion and lixiviation.

The CHAIRMAN.—The Chinese simply pour hot water on the leaf, and pour it off immediately.

MR. LOYSEL.—Yes, but they have no war tax or duty on tea. I believe the flavour of tea properly made in this machine is superior to any extract in the tea-pot, especially if you draw it at once.

MR. LOYSEL then performed the process of making tea and coffee with his machines; and, in a very short time, made a large quantity of both beverages, which was served out in cups to the ladies and gentlemen present, who proclaimed it excellent.